International Marine Engineering

OCTOBER, 1908.

THE NEW ITALIAN STEAMSHIP EUROPA.

BY DAGNINO ATTILIO.

To the Veloce Company, of Genoa, a notable addition has again been made from the shipyard of Palermo in the *Europa,* constructed for the South American Line. She is a handsomely modeled ship, displacing 11,575 tons, of 430 feet in length, with a beam of 53 feet and a depth of 30 feet 10 inches, built under the special survey of the Registro Italiano and of Lloyds, to qualify for their highest class.

She is built of steel, with two complete steel decks, a cellular double bottom and poop, bridge and forecastle erections. The passenger accommodation throughout is very comfortable for 1,700 third class passengers and 74 first class.

THE NEW ITALIAN MAIL STEAMSHIP EUROPA, IN SERVICE TO SOUTH AMERICA.

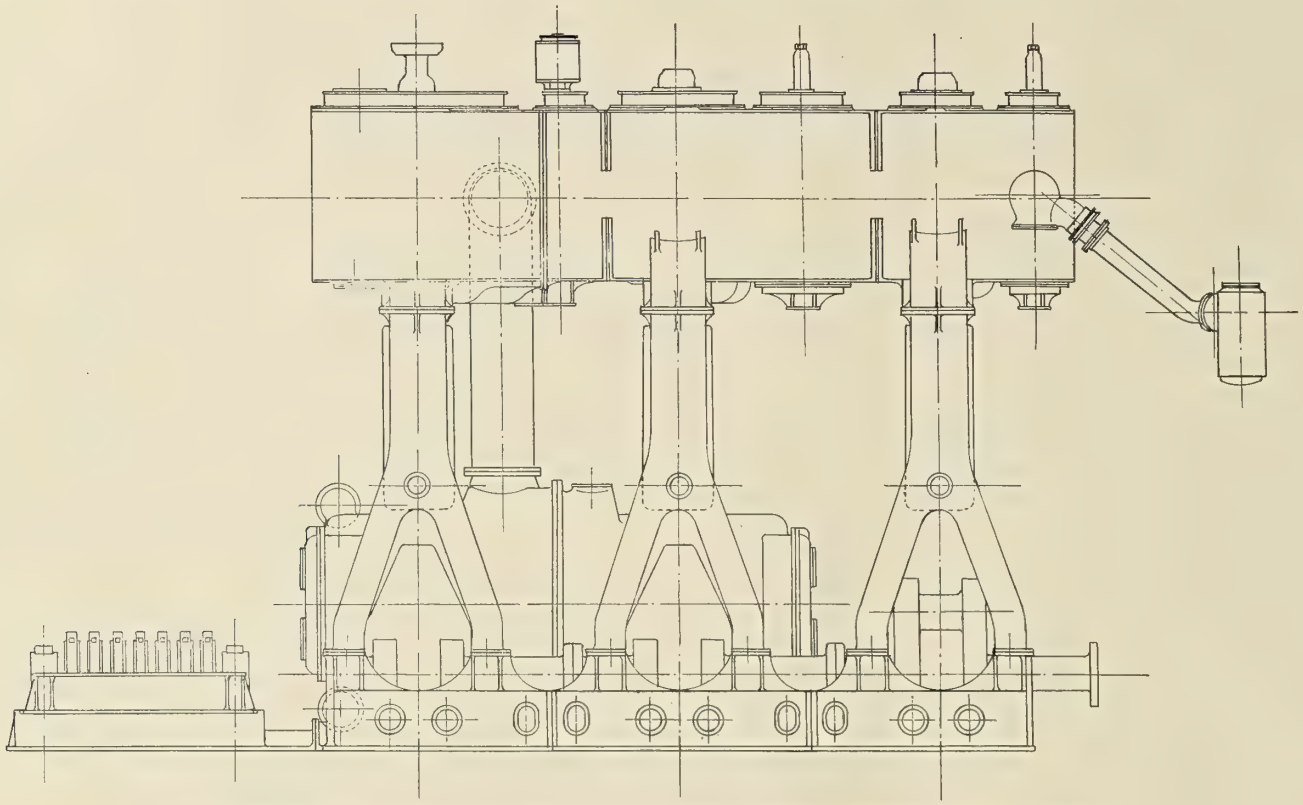
THE MACHINERY.

The propelling machinery was supplied from Gio Ansaldo, Armstrong & Company, Sampierdarena. There are two main engines of the three-cylinder, vertical, inverted, direct-acting, triple expansion type, balanced according to the Schlick system, and each capable of developing about 3,500 indicated horsepower at 90 revolutions per minute, and a steam pressure of 190 pounds per square inch. The sequence of cylinders, beginning forward, is: high-pressure, intermediate-pressure and low-pressure, with, respectively, 26, 42½ and 70⅞ inches diameter, and a common stroke of 51¼ inches. The cranks follow each other in the regular order of size of cylinders, the high-pressure being followed by the intermediate and low-pressure. On account of balancing, these cranks are at 120 degrees.

The high-pressure and the intermediate cylinders have each one piston valve, with diameters, respectively, 15¾ and 26¾ inches on the top and 15¼ and 26 inches on the bottom end. The low-pressure cylinder has a flat, double-ported slide valve. The valve stems are in all cases of a diameter of 4 5/16 inches, while the piston rods have each a diameter of 7⅛ inches. All valves are operated by Stephenson link motion from eccentrics, and can be worked by both steam and manual power. The valve strokes are 9 1/16 to 10 1/16 inches, respectively, for 0.66 and 0.74 cut-off. The length of the connecting rods is twice the cylinder stroke.

The main engines are in a single engine room without center line bulkhead, the starting platforms being conveniently located between the engines, with ample space for the engine crew to work in. The cylinders are safely bolted together, but there is no rigid fastening between them, thus allowing fore-and-aft play for expansion. Each of them is fitted with safety valves in the bottom and cover. They are supported by hollow cast-iron box columns, and these, in the neighborhood of the engine platforms, are utilized for oil storage, and provided with taps and pipes for filling them and for drawing off oil as needed. All stuffing box packings of the main engines, the piston rods and valve rods are metallic.

The main steam pipe has a diameter of 9 1/16 inches. The pipe carrying steam from high-pressure to the intermediate is 13⅜ inches, and the two pipes carrying steam from the intermediate to the low-pressure cylinder have each a diameter of 13¾ inches.



LONGITUDINAL ELEVATION OF EUROPA PROPELLING ENGINE, SHOWING CONDENSER IN EACK COLUMN.

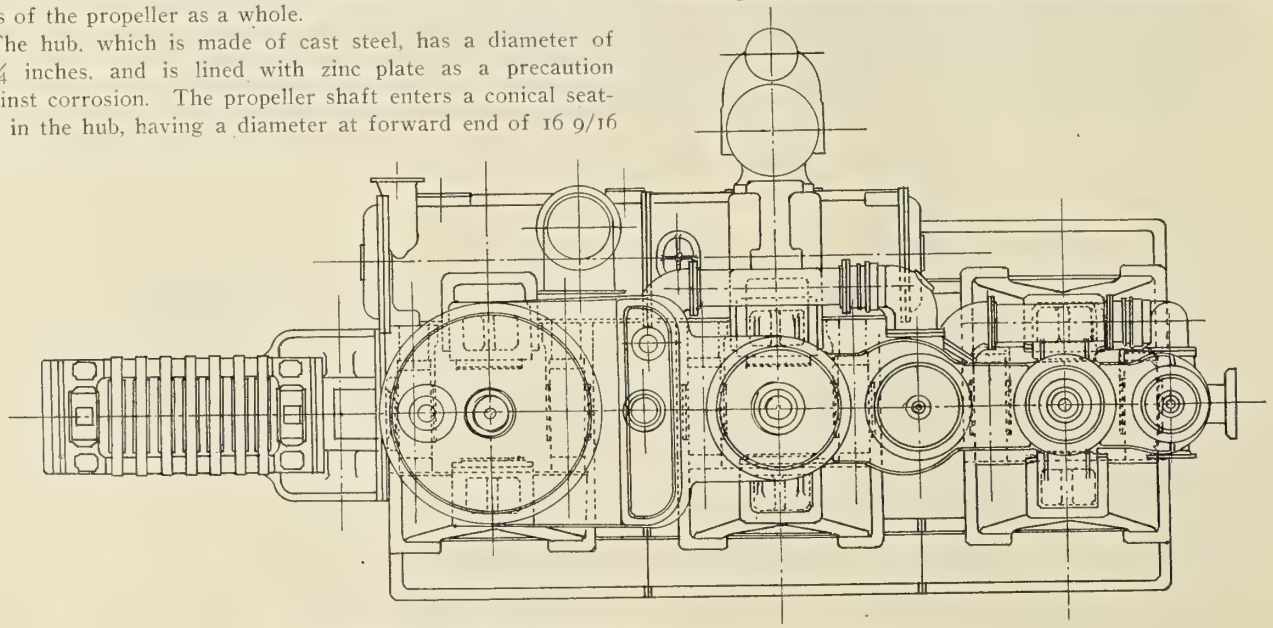
The shafting, which is made of best steel, has a tensile strength of 25.4 to 29.4 tons per square inch, and an elongation of 20 to 25 percent. The crank shaft diameter is 14 11/16 inches; thrust shaft, 14 11/16 inches; line shaft, 14 inches, and propeller shaft, 16 9/16 inches.

The two propellers, which are three-bladed, of the built-up type, turn outboard when going ahead. They are of manganese bronze, and have a diameter of 16 feet 5 inches, and a pitch of 20 feet 7¾ inches at the periphery and 19 feet 8¼ inches at the boss. The mean pitch ratio is 1.23. The projected surface of each propeller is 67.97 square feet, the developed surface 84.17 square feet, and the ratio of projected area to disk area 0.314. The propeller blades are pitched aft, the axis of the blade at the tip being 12 inches aft of the axis of the propeller as a whole.

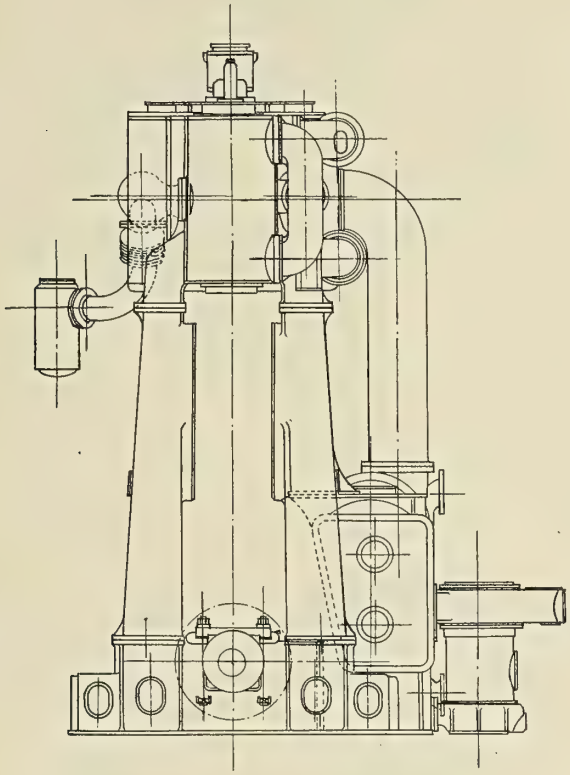
The hub, which is made of cast steel, has a diameter of 47¼ inches, and is lined with zinc plate as a precaution against corrosion. The propeller shaft enters a conical seating in the hub, having a diameter at forward end of 16 9/16 inches, and at the after end of 13¾ inches. This conical portion has a length of 3 feet 7 7/16 inches. A cap, covering the end of the shaft, protects the nut which holds the propeller in position. Each blade is fastened to the hub by means of nine studs.

THE BOILERS.

Four double-ended boilers of the cylindrical type, working at a pressure of 190 pounds per square inch, are located in one boiler room, and have two funnels. The furnaces have internal and maximum diameters of 3 feet 8⅜ inches and 4 feet ¼ inch. The thickness is ⅝ inch. The grates are 6 feet 6¾ inches in length, the grate surface for each boiler being 145.3 square feet; while the heating surface in each boiler figures out at 4,359 square feet, or a ratio of 30 to 1,



PLAN OF TRIPLE EXPANSION PROPELLING ENGINE OF ITALIAN STEAMSHIP EUROPA.



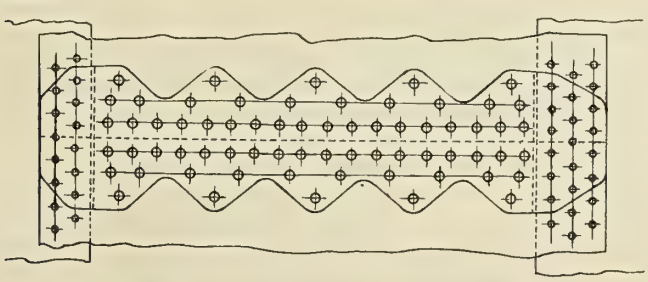
HIGH-PRESSURE END OF EUROPA ENGINE.

making for four boilers an aggregate grate surface of 581.2 square feet, and a total heating surface of 17,436 square feet.

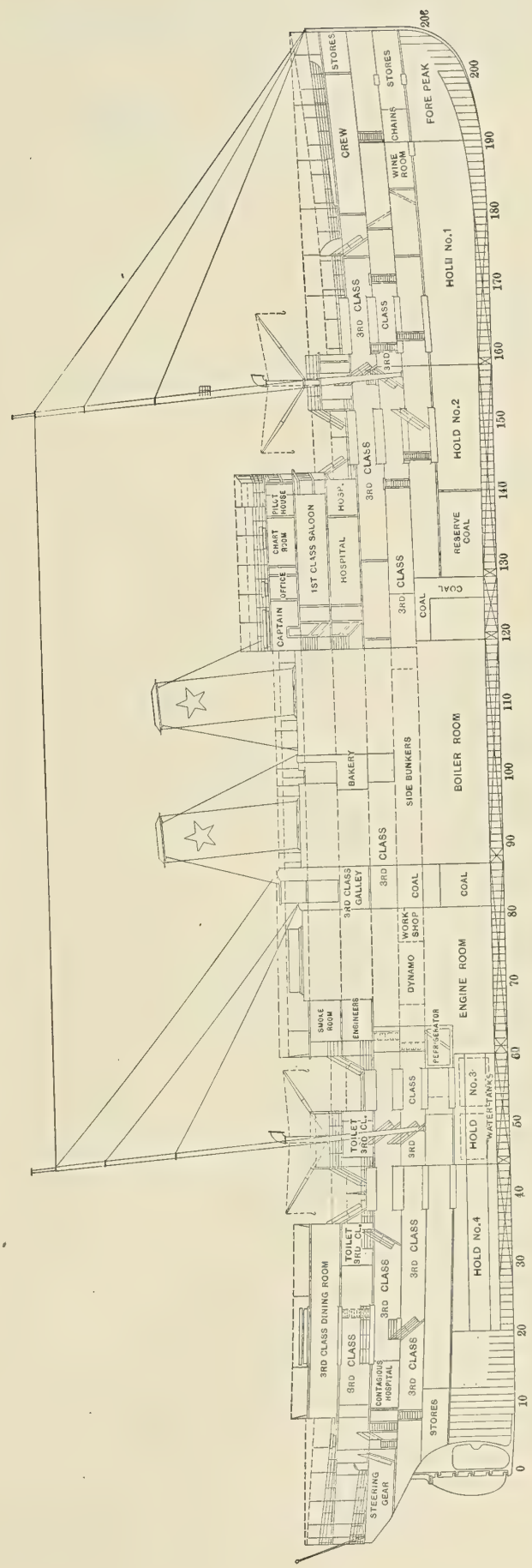
The boilers have a length over the ends of 18 feet 10¾ inches, and they are made in three courses, two being outside and one inside. The improvement in the longitudinal butt-strap seams is remarkable, they having only two rows of rivets running in the middle of the seams instead of four as are used in many other cases (see figure). The mean diameter is 14 feet 6½ inches, while the thickness of the plate is 1¼ inches.

Each boiler contains three Morison suspension furnaces in each end, with a separate combustion chamber for each pair of furnaces opposite each other. The length of tubes between tube sheets is 7 feet 5¾ inches, and they are placed 4 5/16 inches apart in each direction. Each end of boiler contains 298 tubes, of which 96 are stay-tubes and 202 are ordinary tubes. All have an outside diameter of 3¼ inches, with a thickness of 0.260 inch for the stay-tubes, and 0.164 inch for the others. The front tube sheets have a thickness of 29/32 inch, while the back tube sheets are 1 3/32 inches thick. The top of combustion chamber, ⅝ inch thick, is supported by the usual bridge girders, there being four on the central chamber and five on each of the side chambers.

The funnels, which have a crushed circular section, consist of an inner and outer tube, with sufficient air space between them; the area is 15 percent more than that of the boiler tubes.

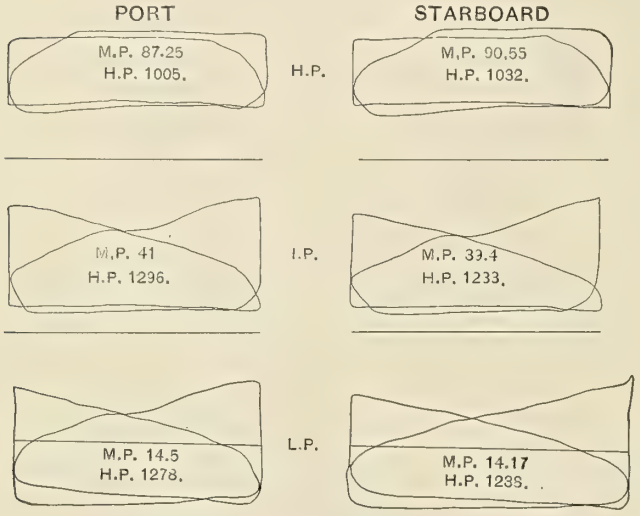


BUTT STRAP, SHOWING DETAIL OF RIVETING.



INBOARD PROFILE OF NEW ITALIAN EMIGRANT STEAMER EUROPA.

The indicator cards shown were taken on trial trip, with a boiler pressure of 197 pounds per square inch. The revolutions were: port, 89; starboard, 88. The vacuum: port, 26.5 inches; starboard, 26 inches. A total of 7,082 indicated horsepower was registered by the main engines.



INDICATOR CARDS FROM ENGINES OF EUROPA.

THE AUXILIARY MACHINERY.

The two main condensers have cooling surfaces amounting to 3,660 square feet each, while the auxiliary condenser has a cooling surface of 538 square feet. The cooling pipes are of brass, with a diameter of ¾ inch. The air pumps measure 25¼ inches in diameter, with a stroke of 25⅝ inches. The pump barrel is a bronze casting ¾ inch thick. Each main condenser is fitted with one circulating pump, operating at 160 revolutions per minute, of sufficient capacity to deliver the cooling water required for both engines when working with full steam.

Two feed pumps for each engine are fitted, to be used when needed for boiler feed; they consist in all their parts of bronze, and have a plunger of 3¾ inches diameter, the stroke being 25⅝ inches. There are fitted two single-acting bilge pumps and two pumps for sanitary purposes, of the same stroke as the feed pumps, and with 4 5/16 inches diameter. The barrel of the bilge pumps is cast iron and the plunger brass.

Besides these there are two evaporators, capable of giving 18 tons of fresh water in twenty-four hours. There are two Weir pumps, each with a capacity of 50 tons per hour, and two duplex steam pumps, which are each to draw drinking water, either from the tanks of the double bottom into a tank arranged in the engine room or directly into a tank on the promenade deck. In addition to these pumps there is a circulating pump for the auxiliary condenser, working at 180 revolutions.

The two starting engines have each two cylinders of 6 inches diameter, with a stroke of 6 inches. The turning engines have each one cylinder 6⅜ by 7½ inches.

The *Europa* is lighted throughout by electricity, and provided with a wireless telegraph equipment fitted in a room of the officers' house on the boat deck, telephones, a complete bell system, ventilating fans and a refrigerating plant.

The contract for constructing the three new United States naval colliers has been awarded to the Maryland Steel Company. The contract price is $479,000 (£98,427) for each. Work on the colliers will be started immediately, and they will be completed within a year.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

CALCULATIONS FOR PISTON ROD, CROSS-HEAD AND SLIPPER.

Formula (20): $W = \dfrac{2 \times 1{,}000 \times 33{,}000}{850} = 77{,}700$ pounds.

Assume $C = 70{,}000$ pounds, $l = 42 + 23.5 + 4 = 69.5''$, (Use $70''$) $N = 15$.

Then $f = \dfrac{70{,}000}{15} = 4{,}670$ $\quad F = \dfrac{2 \times 77{,}700}{3.142 \times 4{,}670} = 10.6$

Formula (21):

$$D^2 = \sqrt{\frac{0.48 \times 10.6 \times 70{,}000 \times (70)^2}{10{,}000{,}000}} + (10.6)^2 + 10.6$$

$$= \sqrt{174.5 + 112.5} + 10.6 = 16.9 + 10.6 = 27.5 \qquad D = 5.25$$

Formula (23):

$$D' = \sqrt{\frac{40 \times 77{,}700}{3.142 \times 70{,}000}} + 0.325 = 4.085'', \text{ (Use } 4'').$$

Allowing a shoulder of ⅛ inch at each end of the rod, and tapering at the rate of 3 inches per foot, the ends of the rod will be as shown in Fig. 26. Assume breadth of cross-head block $= 1.8 \times 5.25$ inch $= 9.45$ inches (use 9½ inches). Cross-head pins will be $5.25 \times 1.2 = 6.30$ inches (use 6¼ inches).

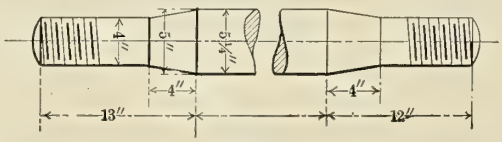


FIG. 26.

Assume allowable unit pressure on pins to be 1,000 pounds per square inch.

$$l \times d = \frac{77{,}700}{2 \times 1{,}000} = 38.85, \quad l = \frac{38.85}{6.25} = 6.22, \text{ (Use } 6\tfrac{1}{4}'').$$

$$L = 9.5'' + 6.25'' = 15.75''.$$

The crosshead will be made of wrought steel, so that f can be $\dfrac{60{,}000}{12} = 5{,}000$ pounds, $b = 9.5'' - \dfrac{4'' + 5''}{2} = 5''$. (See Fig. 23.)

Formula (24): $h = \sqrt{\dfrac{3 \times 77{,}700 \times 15.75}{2 \times 5.0 \times 5{,}000}} = 8.57'', \text{ (Use } 8\tfrac{3}{4}'').$

Assume $\dfrac{r}{l} = \dfrac{I}{4.5}$; $G = \dfrac{77{,}700}{4.5} = 17{,}250$, P will be taken as 70 pounds.

The slipper is to be like Figure 18, made of cast steel, $f = \dfrac{60{,}000}{12} = 5{,}000$ pounds.

Formula (25): $K \times L = \dfrac{77{,}700}{4.5 \times 70} = 246$ square inches.

Let $L = 13''$ and $K = 19''$.

Assume that the web joining the slipper to the block flange, and clearances, will take up 3 inches. The two backing surfaces will then be each 5 inches wide.

Unit pressure when backing $= \dfrac{17{,}250}{10 \times 19} = 91$ pounds

Formula (26): $t = \sqrt{\dfrac{77{,}700 \times 5 \times 6}{2 \times 4.5 \times 2 \times 19 \times 5{,}000}} = 1.167'',$

(Use $1\frac{1}{4}''$). Add $\frac{1}{2}$ inch white metal for each face.

Total thickness of slipper = $2\frac{1}{4}$ inches.

Backing guide to be of cast iron, stress = 1,500 pounds.

Formula (26):

$$t = \sqrt{\frac{77{,}700 \times 5 \times 6}{2 \times 4.5 \times 2 \times 19 \times 1{,}500}} = 2.13'', \text{ (Use } 2\tfrac{1}{8}''\text{).}$$

Assume backing guide bolts to be $1\frac{1}{4}$ inch diameter. Each guide carries a load of $\frac{77{,}700}{4.5 \times 2} = 8{,}633$ pounds.

$$e = \frac{5''}{2} + 0.5'' + \frac{1.25''}{2} = 3.625''; \quad g = 1.25 \times 1.5 + 0.75 = 2.625'';$$

$$\frac{e+g}{g} = \frac{3.625 + 2.625}{2.625} = 2.38.$$

If bolts are spaced $7 \times 1.25'' = 8.75''$ apart, the number needed will be $\frac{42+19}{8.75} = 7$ (approximately). The load upon each bolt will be $\frac{8{,}650 \times 2.38}{7} = 2{,}945$ pounds. From Table IV., a bolt $1\frac{1}{4}$ inch in diameter can carry 3,520 pounds. Try $1\frac{1}{8}$-inch bolts.

Spacing = $7 \times 1.125'' = 7.875''$; $\frac{42+19}{7.875} = 8$ (approximately).

$$e = \frac{5}{2} + 0.5 + \frac{1.125}{2} = 3.56''; \quad g = 1.125 \times 1.5 + 0.75 = 2.43'';$$

$$\frac{3.56 + 2.43}{2.43} \times \frac{8{,}650}{8} = 2{,}670 \text{ pounds.}$$ From Table IV., a bolt $1\frac{1}{8}$ inch in diameter can carry 2,670 pounds; therefore, use $1\frac{1}{8}$-inch bolts.

Use four bolts for attaching slipper to crosshead block. $G = 17{,}250$ pounds; $\frac{17{,}250}{4} = 4{,}325$. From Table IV., bolts should be $1\frac{3}{8}$ inch diameter.

Engine calculations should be tabulated in some systematic way so that they can be readily compared one with another. Fig. 27 shows an abbreviation of the form used by the Bureau of Steam Engineering, United States navy, and when results are tabulated in this way, attempts to lighten construction can be made in an intelligent manner by progressively decreasing the factor of safety of different parts, as experience shows this to be permissible. It will be noticed, in the results given, that the factor of safety varies from 9 to 19 for the middle of the piston rod. It would not seem that the factor of safety need be as great as 19 if rods have worked satisfactorily with a factor of 12 or 15. The quantities J, R_2 and N, given in Fig. 27, are portions of equation (21) in a slightly different form. The factor of safety obtained from the expression

$$N = \frac{A \times C}{W \times R}$$

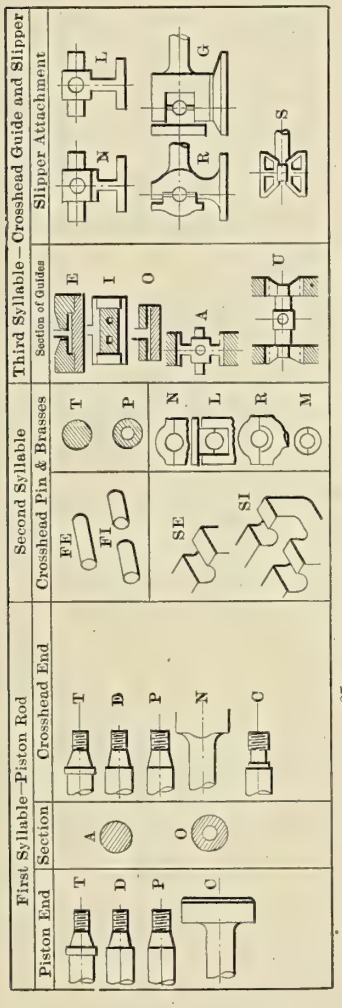


FIG. 27. DETAILS OF PISTON ROD, CROSSHEAD AND GUIDE.

Number.	Type.	Designed Load $W = \frac{2 \times \text{I.H.P.} \times 33{,}000}{P\,S}$
1	Destroyer.....	76,000
2	Torpedo boat.....	33,500
3	Gunboat.....	65,300
4	Revenue cutter...	74,250
5	Battleship.....	295,000
6	Freighter.....	55,400
7	Freighter.....	78,400
8	Passenger boat...	99,000
9	Passenger boat...	78,500
10	Atlantic liner.....	164,000
11	Pacific liner.....	175,000
12	Pacific liner.....	171,500
13	Atlantic liner.....	339,000

Number.	Description.	Factor of Safety $N = \frac{A\,C}{W\,R}$
1	TON–SEL–ER...	9.05
2	TON–SEL–ER...	11.4
3	DON–SEL–EG..	15.3
4	TAP–FIT–EN...	17.8
5	TOC–FIP–EN...	10.8
6	DAD–FIT–EN...	18.2
7	DAD–FIT–EN...	17.75
8	TAD–FIT–AN...	12.2
9	DAD–FIT–EN...	19.2
10	CAD–FIT–EN...	15.8
11	TAP–FIT–EN...	18.5
12	TAD–FIT–US...	16.
13	TAD–FIT–US...	16.7

Diameter of Rod	Length of Rod l.	Radius of Gyration G.	$J = \frac{2I}{3G}$	Specified Ultimate Strength C.	Ratio Load at Middle to Steam Load $R = 1 + \frac{J^2 C}{\pi^2 E}$	Length Conn. Rod / Crank $\frac{l}{r}$
$4\frac{1}{4}$–$2\frac{3}{4}$	$39\frac{1}{16}$	1.265	20.59	95,000	1.134	4.25
3 –$1\frac{13}{16}$	$24\frac{1}{16}$	0.876	22.12	95,000	1.155	4.44
$4\frac{1}{2}$–2	$47\frac{1}{8}$	1.23	25.6	95,000	1.208	4.46
5	$50\frac{1}{4}$	1.25	26.85	80,000	1.192	5.
8 –$3\frac{3}{8}$	81	2.195	24.7	95,000	1.194	4.
5	$66\frac{3}{8}$	1.25	35.5	70,000	1.241	4.57
6	$74\frac{5}{16}$	1.5	33.1	60,000	1.219	4.5
$5\frac{1}{2}$	$65\frac{3}{4}$	1.32	33.2	70,000	1.258	4.5
$5\frac{3}{4}$	64	1.44	29.6	70,000	1.205	4.5
$7\frac{1}{2}$	82	1.88	29.1	70,000	1.198	4.44
8	91	2.	30.3	80,000	1.245	4.42
8	$104\frac{1}{2}$	2.	34.7	70,000	1.28	4.18
11	114	2.75	27.6	70,000	1.176	4.

Number.	Factor of Safety at Root of Thread. Piston End.	Factor of Safety at Root of Thread. Crank End.	Cotan Sec $\frac{l}{r} = \frac{H}{W}$.	Load on Crosshead Guide H	Ahead. Dimensions of Slipper.	Ahead. Pressure per Square Inch.	Backing. Dimensions of Slipper.	Backing. Pressure per Square Inch.
1	8.8	7.65	0.242	18,400	11 x16	104.	2x 3 x16	211.
2	10.4	11.6	.231	7,740	$7\frac{1}{2}$x$13\frac{1}{2}$	76.5	2x 2 x$13\frac{1}{2}$	143.
3	10.4	9.6	.23	15,200	12 x$14\frac{1}{2}$	87.5	2x $4\frac{7}{8}$x$14\frac{1}{2}$	108.
4	10.8	10.8	.204	15,150	13 x16	73.	2x 5 x16	95.
5	7.15	7.15	.258	76,200	23 x30	110.	2x $8\frac{1}{2}$x30	149.
6	12.2	12.2	.224	12,400	12 x19	54.5	2x $4\frac{1}{2}$x19	73.
7	11.8	11.8	.228	17,900	14 x$22\frac{1}{2}$	57.	2x $4\frac{1}{2}$x$22\frac{1}{2}$	89.
8	10.9	10.9	.228	22,600	12 x24	78.2	12 x24	78.2
9	15.3	15.3	.228	17,900	16 x24	46.6	2x 6 x16	99.4
10	12.7	12.7	.231	37,900	$22\frac{1}{2}$x30	56.1	2x $8\frac{3}{4}$x30	75.2
11	11.5	11.5	.232	40,650	24 x30	56.5	2x 8 x30	85.
12	10.3	10.3	.246	42,200	2x28x11	68.5	2x28 x11	68.5
13	11.3	11.3	.258	87,700	2x20x47	46.7	2x20 x47	46.7

should be the same as the factor of safety N used in equation 21. In the expression for R, π^2 is assumed to be 10. and E is assumed to be 30,000,000.

Connecting Rod.—The body of the connecting rod is figured

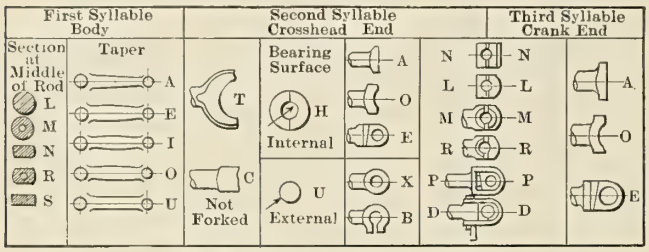


FIG. 28.—CONNECTING ROD DETAILS.

Number.	Type.	Description.	Length of Rod, Center to Center, L.	$\frac{L}{r}$.	Cosec Sec$^{-1}\frac{L}{r}=K$.	Load on Rod $=Wk=P$.	Specified Ultimate Strength, C.	Ratio Load at Middle to Load at Ends $=R=1+\frac{L^2C}{C^2\pi^2E}$
21	Destroyer.....	MA–TUX–MO...	46¾	4.25	1.03	78,200	95,000	1.489
22	Torpedo boat...	SAI–TUX–LA...	40	4.44	1.027	34,400	95,000	1.307
23	Gunboat.....	MA–TUX–NA...	67	4.465	1.026	67,000	95,000	1.957
24	Revenue cutter.	LA–THAN–NA..	75	5.	1.021	75,800	80,000	1.761
25	Battleship.....	MA–THAN–NA..	96	4.	1.032	304,200	95,000	1.495
26	Towboat.....	LA–THAL–LA...	65	5.	1.021	37,300	65,000	1.88
27	River boat.....	LA–TUX–NA....	68	4.535	1.026	42,200	95,000	1.845
28	Freighter.....	LA–THAN–LA..	94½	4.5	1.026	72,700	60,000	1.649
29	Passenger boat.	LA–THAN–NA..	94½	4.5	1.026	90,500	70,000	2.02
30	Atlantic liner...	LA–THAN–NA..	120	4.45	1.027	148,000	70,000	1.85
31	Pacific liner....	LA–THAN–LA..	128	4.18	1.031	176,800	70,000	2.

Number.	Smallest Section of Rod. Dimensions.	Shape.	Area.	Factor of Safety.	Section at Middle of Rod. Dimensions.	Shape.	Area A.	Radius of Gyration G.	$\frac{L}{G}$.	Factor of Safety at Middle of Rod $=N=\frac{AC}{PR}$
21	3⅞–2¼	M	7.817	9.5	4.2 –2¼	M	9.878	1.19	39.3	8.57
22	4.05x1¼	S	5.063	13.9	4.45x2	S	8.9	1.285	31.1	18.8
23	4¼–2	M	11.05	15.7	4.44–2	M	12.36	1.218	55.	8.95
24	5	L	19.64	20.8	5.62	L	24.8	1.405	53.3	14.9
25	7¼–5	M	27.54	8.6	8⅜–5	M	35.43	2.44	39.3	7.4
26	3¾	L	11.04	19.2	4.09	L	13.13	1.02	63.75	12.2
27	4	L	12.57	19.3	4.35	L	14.97	1.09	62.4	12.5
28	6¼	L	30.68	25.4	6.64	L	34.55	1.66	57.	17.3
29	5	L	19.64	15.3	5¼	L	26.	1.44	65.6	10.
30	7¼	L	41.4	19.6	8	L	50.2	2.	60.	12.8
31	7½	L	44.18	17.5	8½	L	56.75	2.125	65.	11.22

as a column hinged at both ends, and the formulæ have the same form as those for the piston rod, except that the constant is 1.08 instead of 0.48, and the factor of safety used is different. The middle portion of the rod is usually made tapered, and the formulæ give the diameter at the middle of the rod.

Solid rod:

$$D^2=\sqrt{\frac{1.08\times F\times C\times l}{10{,}000{,}000}+F^2}+F. \qquad (27)$$

Hollow rod:

$$D^2=\sqrt{\frac{1.08\times F\times C\times l}{10{,}000{,}000}+F^2+(2F+d^2)d^2}+F. \qquad (28)$$

$F=\frac{2P}{\pi f}$; P = load upon connecting rod $=W\times k$; W = load on piston rod; l = length of connecting rod $=h\times$ stroke; h varies from 2 to 2½:

When $h=$	2	2.125	2.25	2.375	2.5
$k=$	1.033	1.03	1.026	1.023	1.021

f = allowable stress on rod, $=\frac{C}{N}$;

C = ultimate strength of material,
= 60,000 to 70,000 pounds for merchant engines,
= 80,000 to 95,000 pounds for naval engines;

N = factor of safety,
= 8 to 10 for naval engines,
= 12 for merchant engines;

d = inside diameter of rod, and is usually from

$$\tfrac{1}{2}\sqrt{2F} \text{ to } \tfrac{2}{3}\sqrt{2F}.$$

The increase of the stress at the middle of the rod, due to the tendency of the rod to spring when being compressed, is generally about 75 percent (see column marked R, Fig. 28), so that theoretically the area at the very top of the column could be 57 percent of that at the middle and have no greater stress. The fork of the rod takes up about one-fourth of its length, so that the area at the smallest section should be about 80 percent of the area at the middle. In order that the area may be 80 percent, the diameter must be 90 percent. Due to the swinging of the rod across the line of the dead centers, and its being brought to rest on either side of the crank pin, there is bending introduced near the crank-pin box from the inertia of the rod. This additional bending is seldom figured, but the diameter here is increased as much as the diameter at the upper end is decreased, so that the rod has a uniform taper from end to end. The diameter at G, Fig. 29, should be 0.9 H, and the diameter at I should be 1.1 H.

The distance Z between the flat faces of the fork is made equal to G, or slightly greater. The heads of the cap bolts of the boxes of the fork must clear these faces by about ⅛ inch, and the diameter of the cross-head pin should be such that it clears the body of these bolts by about ¼ or ⅜ inch. It may be necessary to change the diameter of the cross-head pin after finding the diameter of these bolts, in order that there may be not too much nor too little clearance here.

The four bolts at the cross-head end, and the two at the crank-pin end, of the rod should be designed to carry the load P, and their diameters can be taken from Table IV. The nuts for the bolts are usually of the collar type, shown in Fig. 5 and Table V. The boxes at the forked end are made with E greater than K (see Fig. 29); the amount of the overhang to be allowed in any case being determined by comparison with a similar rod in the table accompanying Fig. 29. F should be taken from the computation for the cross-head block, allowance being made for the facing strip and a slight clearance, 1/32 inch or less. $W=F+E-K$, E being equal to the length of the cross-head pin. V should be taken from the details of the cross-head block, the bottom of the fork clearing the end of the piston rod nut by about the thickness of the nut. The thickness Q should be from ¼ to ½ inch greater than X.

The thickness S of the caps is determined by considering the cap as a beam of breadth K, supported at the ends by the cap bolts; so that the span is T. As the load is distributed over a part of the beam, the bending moment is generally obtained from the formula

$$M=\frac{W\times l}{6}, \text{ where } l=T, \text{ and } W=\frac{P}{2}; \text{ thus } M=\frac{P\times T}{2\times 6};$$

$$I=\frac{K\times S^3}{12}; f=\frac{M\times y}{I}=\frac{P\times T}{2K\times S^2};$$

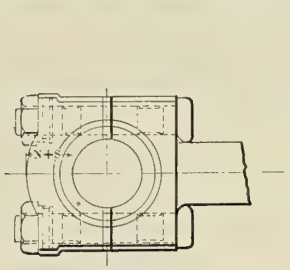


FIG. 29.

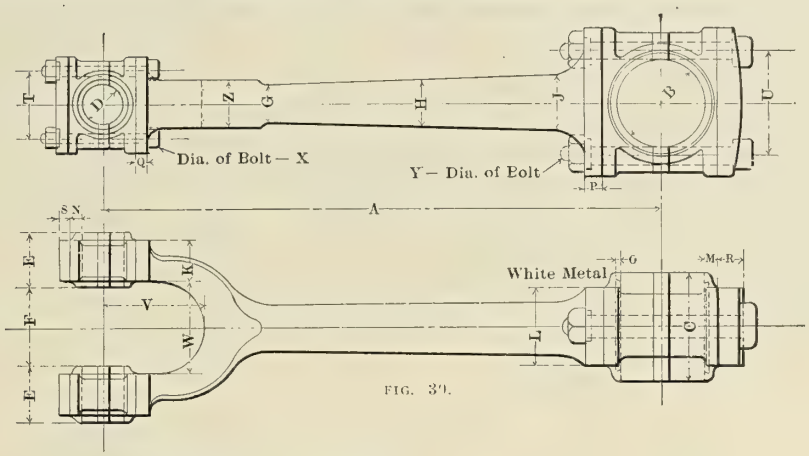


FIG. 30.

CONNECTING ROD AND DETAILS.

No.	A / Crank.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	4.8	72″	9″	8 7/8″	4 1/2″	4 1/2″	7″	3 3/4″	4 1/8″	4 1/2″	3 1/2″	7″	1 3/4″	1″	3/8″	3″	2 1/4″	3″	2 1/4″	6 7/8″	12 3/8	10	8	1 3/4	2 1/2	3 3/4″
2	5.	60	9	10 3/8	4 1/2	4 1/2	7 1/2	3 7/8	4 3/16	4 1/2	3 3/4	8	1 5/8	....	1/2	3	2	2 3/4	N + S 2 5/8	6 5/8	12 1/4	11	9	1 3/4	2 1/4	3 3/8
3	....	54	10 1/2	9 5/8	5	5 1/4	7 5/8	4	4 3/8	4 3/4	4 1/4	7 1/2	1 1/2	5/8	3/8	3 5/8	2 1/8	3 5/8	2 3/8	7 1/2	14	11	8 5/8	2	2 3/4	4 1/4
4	....	60	9	9	4 1/2	5	7 1/2	4	4 1/2	5	4	6 3/4	1 1/4	....	....	3 3/8	2 1/2	2 3/4	N + S 2 1/4	7 5/8	12 3/8	10	8 1/2	2	2 1/4	4
5	4.5	81	12 3/4	15	7 3/4	8 1/2	10 1/4	5 3/4	6	6 1/2	6 1/2	10 1/2	2 3/8	1 1/2	3/4	4	3 1/4	..	..	....	....	....	....	3 1/4	4	....
6	4.	84	15	16 3/4	7 1/2	9	13	6 3/8	7 1/2	8 1/2	7 1/2	12	2 7/8	1 1/2	1/2	....	3 1/2	4 1/2	N + S	11 1/2	20 1/2	12 1/2	15 1/2	3	4 1/4	6 3/4
7	4.18	138	20 1/2	18 5/8	10 1/2	9 7/8	11 5/8	7 1/2	8 1/2	9 1/2	7 3/4	13 1/2	2 3/4	1 1/8	3/4	5 1/2	4	R + M 8 1/4	4 1/4	14 3/4	26 1/2	20 1/8	13 3/4	3 3/4	5	8

then
$$S = \sqrt{\frac{P \times T}{2 \times K \times f}}. \qquad (29)$$

Where P = load upon connecting rod;
T = distance between center lines of cap bolts;
K = breadth of cap;
f = allowable stress.

The load upon the caps is intermittent in character, so that the factor of safety should be 8. The caps are usually made of bronze, cast steel or wrought steel. The thickness N of the brasses can be taken from the table of Fig. 29. The thickness of the metal of the caps, where they inclose the bolts, is generally about $\frac{X}{4}$. Between the upper and lower brasses there is one thick cast iron liner, usually from 1 inch to 1¾ inches in thickness, held in by dowel pins and several thin tin liners varying from 1/16 to 1/64 inch.

The fork of the connecting rod is figured as if the ends were free to move. The force $\frac{P}{2}$, considered as acting at the middle of the length of the box, will cause bending, direct compression and shear upon a given section of the fork. It is usual to consider only the bending, and to allow for the direct compression and shear by using a low stress. The design can be simplified by proceeding as in Fig. 31. The inside of the fork is semi-circular in shape, the semi-circle at its lowest point being a distance V from the center line of the cross-head pins, and the radius of the semi-circle being equal to $\frac{W}{2}$, see Fig. 29.

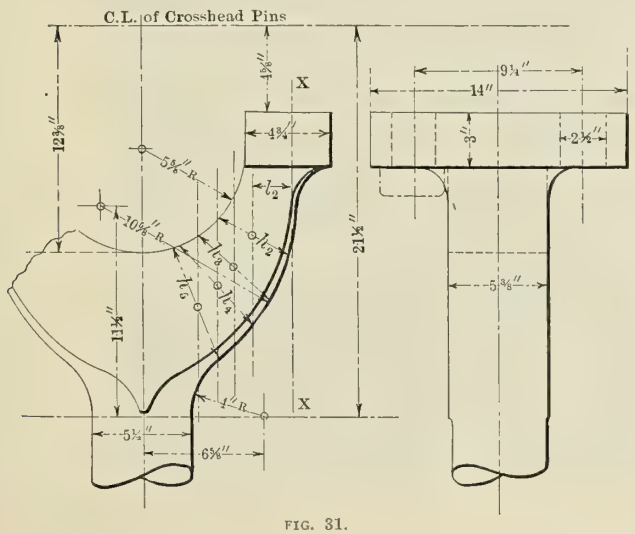


FIG. 31.

To get the outline of the outside of the fork, draw a number of lines a distance l apart, parallel to $X\,X$, which passes through the center of the length of the bearing. Certain sections of the fork lying about normal to its outside edge will have their neutral axes upon these lines. The breadth of the sections will be Z (see Fig. 29), and the length must be sufficient to cause the stress upon them to be within the desired limits. The bending moment upon the section l_1'' distant from $X\,X$ will be $\frac{P \times l_1}{2}$. If h is the length of the section, then

$$f = \frac{P \times l_1 \times h_1 \times 12}{2 \times 2 \times Z \times h^3} = \frac{3Pl_1}{Z \times h^2}$$

or,
$$h_1^2 = \frac{3 \times P \times l_1}{Z \times f}. \qquad (30)$$

Since, for the other sections, everything else is the same except the distance l_1, and since

$$l_2 = 2l_1, \quad l_3 = 3l_1, \quad l_4 = 4l_1, \text{ etc.},$$

then
$$h_2^2 = 2h_1^2, \; h_3^2 = 3h_1^2, \; h_4^2 = 4h_1^2, \text{ etc.}$$

The distances h_1, h_2, h_3, etc., can be laid off about normal to the semi-circle, so that their centers fall on the lines distant l_1'', l_2'', l_3'', etc., from $X\,X$. Through the ends of these lines the edge of the other side of the fork can be drawn. The curves should be arcs of circles, for the sake of convenience. Sometimes the construction of the piece is simplified by substituting a straight line for the curve. In this case the line must pass outside of all the points laid off, and for this reason will give a heavier fork than before.

The crank-pin end of the rod cannot be completed until the size of the crank pin is determined, and this depends upon the size of the crank shaft. When the size of the crank shaft has been determined, and from that the size of the crank pin, the length C (see Fig. 29) of the box should be such that the bearing pressure per square inch does not exceed that given in Table VII. The load upon the crank pin is the resultant of the thrust through the rod, due to the steam pressure on the piston, the inertia and weight of the reciprocating parts, and the centrifugal force of the crank-pin end of the connecting rod. The following formula gives the approximate mean load upon the crank pin:

$$L = 1.6 \times \frac{21{,}000}{P.S.} \times I.H.P., \qquad (31)$$

where $I.H.P.$ = the indicated horsepower of the cylinder over the pin;

$P.S.$ = the piston speed of the engine in feet per minute.

The factor, 1.6, may vary from 1.4 to 1.8, depending upon the distribution of power among the cylinders, as there would be considerable bearing pressure upon the pin, due to the inertia of the reciprocating parts and the centrifugal force of the end of the connecting rod, even if there were very little power being developed in the cylinder. The factor 1.6 is for average conditions, and should be increased if the cylinder develops less than its share of the power, and decreased if more is developed.

The cap of the crank-pin end is designed to carry the total load P, so that the formula for the thickness R becomes

$$R = \sqrt{\frac{PU}{Lf}}, \qquad (32)$$

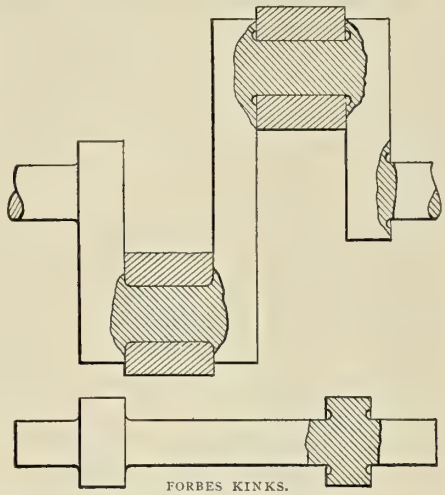
where P = load upon connecting rod (by Formula 20);
U = distance between center lines of bolts;
L = breadth of cap;
f = stress to give a factor of safety of 8.

The bolts, brasses, etc., are obtained in the same way as for the forked end of the rod. The two parts of the box are separated by liners, a cast iron liner whose thickness varies from 2½ to 4½ inches, and thinner brass and tin liners. The cap may be of wrought steel, cast steel or bronze. When made of cast steel or bronze the shape is generally that shown in Fig. 30. The bolts should clear the crank pin by an amount varying from ⅜ inch to ⅝ inch.

(To be continued.)

Fillets on Shafting.

High-speed engines are among the regular products of the shop of W. D. Forbes & Co., Hoboken, N. J., these going largely into naval and other marine service for lighting. This means careful attention to bearings, as they run in warm places and space is limited. Mr. Forbes has made a departure from the usual method of putting in fillets, which is giving good results. In both the crankshaft and the shaft with



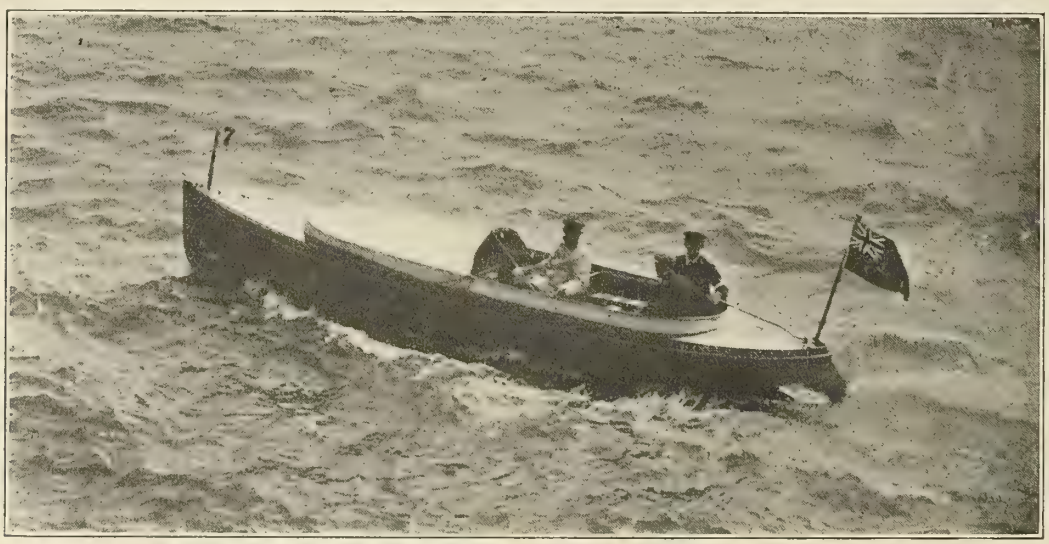
FORBES KINKS.

shoulders, those at the left are of the usual kind. This reduces the length of the bearing somewhat, as only the straight portion can be used for this purpose. It is further objected that, if the bearing heats, it tends to ride up on the fillets, reduce the bearing on the crankpin, and so increase the heating.

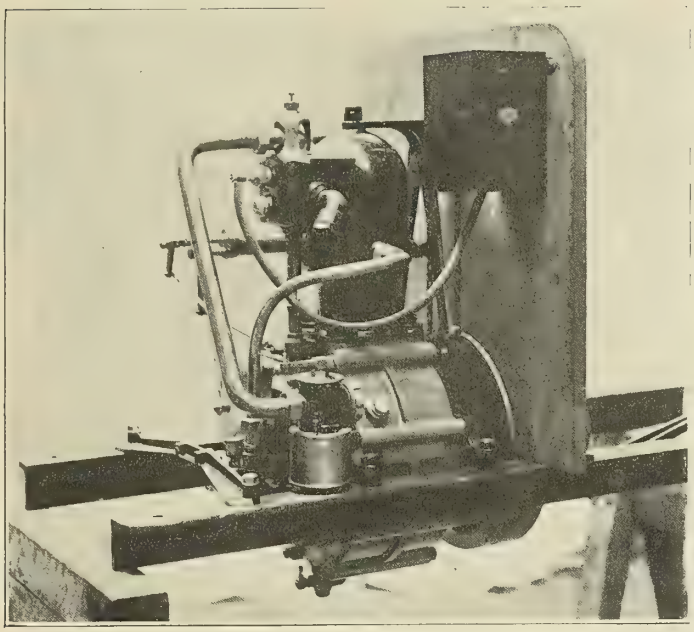
The plan used here is shown at the right. The fillet is cut in the crank face or in the collars of the shaft. This does away with the sharp corner as effectively as the other method, and has worked out well in their practice.—*American Machinist.*

The Petrol Launch Dion Bouton.

This little vessel has been equipped by the De Dion Bouton Automobile Company, Ltd., with an 8-horsepower engine, having a single cylinder 3¾ inches in diameter by 3¾ inches stroke, and operating at 900 revolutions per minute. The boat has a length of 25 feet and a beam of 5 feet 6 inches. The engine is under the after end of the hood covering the forward end of the cockpit, and is thus located about amidships. The speed of the boat is 9 miles per hour.



THE MOTOR LAUNCH DION BOUTON, FITTED WITH AN 8-HORSEPOWER ENGINE.



EIGHT-HORSEPOWER ENGINE OF LAUNCH DION BOUTON.

The Naval Strength of the Nations.*

BY SIDNEY GRAVES KOON.

As has been the case continuously for nearly 200 years, Great Britain occupies the premier naval position at the present time, with 193 ships of upward of 1,000 tons each, active and building, as compared with 117 for Germany, 110 for the United States, and 96 for France. The list following tabulates the situation at the moment for the leading eight powers, with the results of such combinations as the Anglo-Saxon, the Franco-Russian, the Dreibund (Germany, Italy and Austria), and the sum of the two latter:

	Ships.	Displacement, Tons.	Guns.	Average Tons.	Average Knots.	Ships over 10,000 Tons.	Ships over 16,000 Tons.
Great Britain	193	1,897,860	7,540	9,833	20.15	103	20
United States	110	837,208	3,955	7,611	18.97	41	12
France	96	788,573	3,235	8,048	19.09	37	6
Germany	117	780,720	3,844	6,673	19.1	33	9
Japan	48	422,70	1,829	8,806	19.97	18	4
Russia	50	339,689	1,747	6,794	18.38	13	2
Italy	43	321,872	1,681	7,485	20.16	13	1
Austria	27	171,991	866	6,370	19.67	6	...
All others	156	558,285	3,550	3,580	17.9	3	3
Totals	840	6,118,907	28,247	7,284	19.44	267	57
Anglo-Saxon	303	2,735,068	11,495	9,027	19.79	144	32
Franco-Russian	146	1,128,262	4,982	7,727	18.87	50	8
Dreibund	187	1,274,583	6,391	6,816	19.44	52	10
Continental	333	2,402,845	11,373	7,216	19.18	102	18

Such figures as these do not tell the whole story. For instance, the fastest navy is that of Chile, with an average speed of 20.74 knots. Brazil comes next, with 20.18 knots, followed closely by Italy and Great Britain, while Argentina, with 18.88 knots, is ahead of Russia; otherwise the order may be picked from the table. In average size of ships no nation not in the table has an average as great as has Austria, the lowest listed. The only ships of over 10,000 tons belonging to any nation outside the eight tabulated are three battleships building for Brazil in England, and said in some quarters to be ultimately destined for Japan.

An examination of the table shows that the Anglo-Saxon combination is superior to the five combined continental nations in displacement, guns, average size and speed, and much superior in the number of large ships. In total number of ships only are we inferior. Of course, the large advantages accruing from a common language and common ideals would be of enormous benefit should it ever be necessary to measure strengths.

Taking up the eight leading nations in a little more detail, and omitting further all ships under 3,000 tons and all unarmored ships under 18 knots, we get two tables, one covering battleships only, while the second covers cruisers, both armored and protected. In each case the divisions are somewhat arbitrary, but they are thoroughly uniform, and totally fair.

	Battleships.								
	First Class.			Second Class.			Coast Defense.		
	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.
Great Britain	56	862,000	19.08	14	152,070	17.29	2†	18,660	14.43
United States	31	445,679	18.54	..	.....	.....	11	45,339	12.83
France	22	313,956	18.66	8	84,362	15.98	10	66,789	15.33
Germany	20	314,290	19.63	14	152,581	17.61	13	66,634	14.98
Japan	15	231,752	19.8	3	36,308	18.04	3	18,126	14.91
Russia	8	112,134	17.71	4	37,753	16.47	5	32,923	14.7
Italy	10	135,528	21.04	5	62,317	17.74	..	.....	.....
Austria	3	43,500	20.	6	55,923	20.15	5	28,549	17.02

† Lately condemned and about to be sold.

	Cruisers.								
	Armored.			First Class.			Second Class.		
	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.
Great Britain	35	417,360	23.01	23	213,710	20.75	39	176,320	20.11
United States	15	186,651	22.19	3	20,620	22.58	12	47,117	21.27
France	18	190,795	22.07	4	29,655	22.14	16	80,230	19.33
Germany	8	78,381	21.15	..	.....	.....	27	107,996	21.84
Japan	9	81,412	21.53	1	6,500	23.7	8	33,931	21.49
Russia	6	62,644	20.67	6	38,935	23.14	6	32,100	19.46
Italy	7	61,250	21.61	1	6,000	25.	3	17,303	19.44
Austria	1	7,185	22.01	..	.....	.....	5	22,804	20.68

These two tables should be supplemented by another giving the totals, the total battleships and the total armored fleets, as follows:

	Grand Totals.			Total Armored.			Total Battleships.		
	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.	Ships.	Tons.	Speed.
Great Britain	169	1,840,120	20.06	107	1,450,090	19.95	72	1,032,730	18.73
United States	72	745,406	19.39	57	677,669	19.16	42	491,018	18.01
France	78	765,788	19.12	58	655,903	18.97	40	465,107	17.7
Germany	82	719,882	19.27	55	611,886	18.81	47	533,505	18.47
Japan	39	408,029	19.98	30	367,598	19.77	21	286,186	19.33
Russia	35	316,489	18.68	23	245,454	17.87	17	182,810	16.91
Italy	26	282,398	20.39	22	259,095	20.37	15	197,845	20.
Austria	20	157,961	19.71	15	135,157	19.55	14	127,972	19.4

One further table will conclude our study of the question. This deals with the batteries of the various ships, arranged

	12-inch Guns.		8 to 12-inch Guns.		3.9 to 8-inch Guns.		Smaller.
Great Britain	312	(298)	172	(134)	1,915	(1,047)	4,701
United States	172	(172)	224	(162)	728	(374)	2,230
France	103	(100)	108	(62)	859	(472)	1,870
Germany	...	...	326	(299)	741	(371)	2,187
Japan	66	(66)	126	(89)	428	(218)	1,080
Russia	50	(46)	83	(53)	379	(204)	1,035
Italy	44	(44)	97	(69)	310	(161)	788
Austria	17	(15)	63	(51)	210	(108)	448

The Iron Age.

according to the size of gun. The first column shows the number of guns of 12-inch caliber and upward carried on the ships listed, with the broadside fire in parenthesis. The second column shows the guns of 8-inch and upward, but under 12-inch; the third shows those between 3.9-inch (10 cm.) and 8-inch, while the last shows the smaller guns and torpedo tubes.

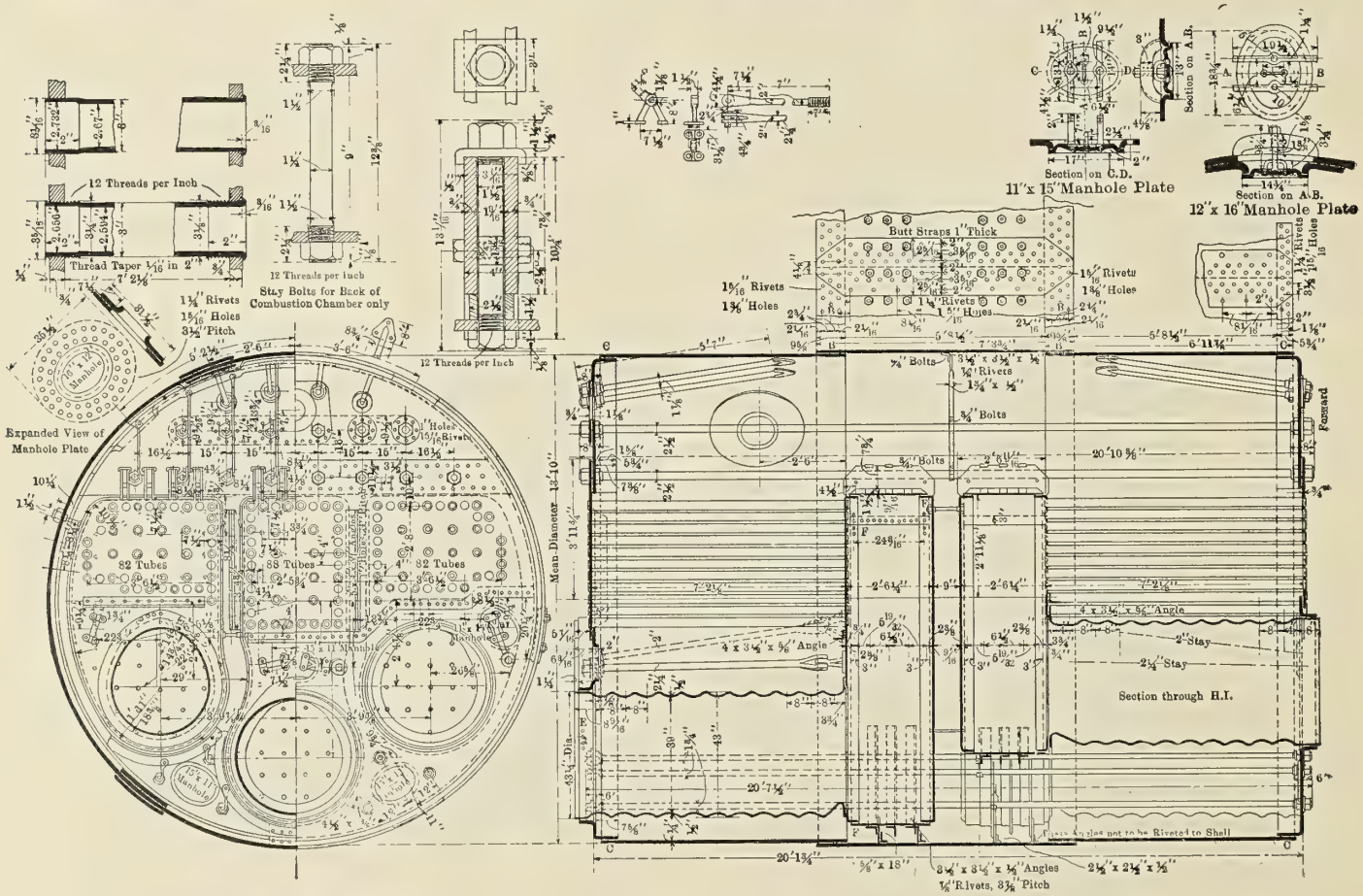
It will be noted that, with regard to number and aggregate displacement of fighting ships, the United States, France and Germany are running a very close race, standing in that order in armored ships, but with little room for choice. When we examine the batteries carried, however, the immense superiority of the United States in heavy guns, and particularly in 12-inch guns, becomes at once apparent. Germany has no guns over 11 inches. In those of 8 inches and upward the United States carries 396, to 326 for Germany (averaging smaller in size) and 211 for France. It will be remembered that in the war of 1812 a large part of the American success at sea was attributed, and rightly, to the American guns and the way they were handled. The United States has to-day a navy with heavier guns on the average than those carried by the ships of any other power, not even excepting England, and reports of target practice leave little doubt that their gunnery is without an equal on the face of the globe.

BOILERS FOR THE U. S. S. YANKEE.*

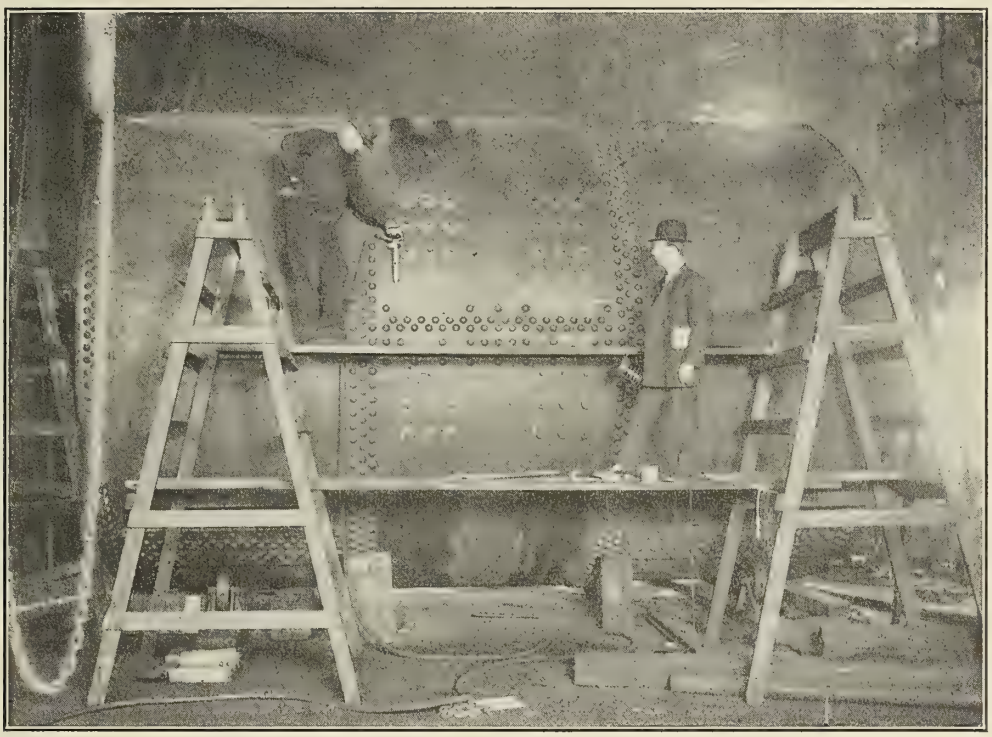
It may not seem to be a very unusual or remarkable accomplishment to the boiler makers in a large, modern, up-to-date contract shop to build three double-ended boilers each 13 feet 10 inches diameter and 20 feet long, with six furnaces and separate combustion chambers, but to carry out this work successfully and rapidly in a navy yard, where the equipment of the boiler shop is suitable only for repair work and small jobs, is a feat worth noting. The boilers for the United States ship *Yankee,* photographs and drawings of which are shown herewith, were built at the Charlestown (Mass.) Navy Yard, under the supervision of Mr. J. R. Truckses, master boiler maker. In this yard the boiler shop is small, and as yet has not been equipped with modern machinery and cranes for handling large and heavy jobs of boiler construction. An endeavor is now being made, however, by the head of the Department of Steam Engineering, Commander George E. Bird, U. S. N., to secure an appropriation for the enlargement of the boiler shop at this yard and the installation of electric cranes and more modern machinery. Certainly the work done at this yard with the available facilities speaks well for the ability and ingenuity of the master boiler maker, and should be a good argument to be used by the chief engineer in his request for an appropriation from Congress to modernize this plant.

The boilers of the *Yankee* are the largest ever constructed in a government navy yard, and have been the source of considerable favorable comment from outside manufacturers who have been fortunate enough to witness their construction. The boilers are 13 feet 10 inches mean diameter by 20 feet 1¾ inches long outside the heads. They are to be operated at a steam pressure of 170 pounds per square inch, and will weigh when completed 68 tons each. Each boiler has six corrugated furnaces with separate combustion chambers and 504 3-inch tubes. The grates are each 6 feet 10 inches long by 3 feet 4½ inches wide, making a total grate area of 138 square feet. There is a total heating surface in each boiler of 3526.97 square feet, divided as follows: Heating surface of tubes, 2840.98 square feet; heating surface of furnaces, 242.25 square feet; heating surface of combustion chambers, 443.74 square

* *The Boiler Maker.*



LONGITUDINAL AND SECTIONAL VIEWS OF YANKEE BOILER, WITH DETAILS OF TUBES, STAYS, RIVETED JOINTS, ETC.



SIDE VIEW OF THE BOILER, SHOWING DETAILS OF RIVETING.

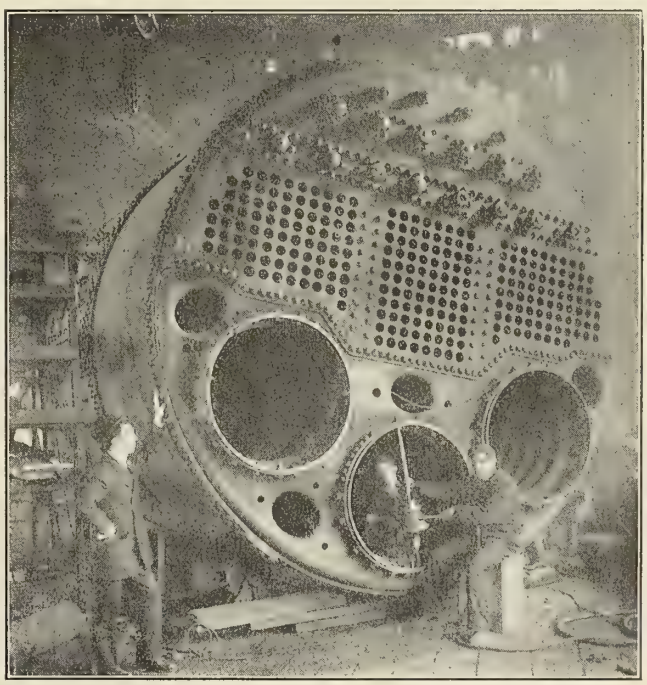
feet. The ratio of heating surface to grate area is therefore 25.55. The area over the bridge wall is 3.11 square feet, and its ratio to the grate area 1 to 7.42.

The shell of the boiler is constructed of three courses of three plates each, the middle course being the outside course. The plate is open-hearth mild steel of 60,000 pounds tensile strength 1¼ inches thick. The longitudinal seams of the shell are triple riveted butt joints, the butt straps being of plate 1 inch thick, fastened with 1¼-inch rivets in 1 5/16-inch holes, pitched 8 1/16 inches between centers. The inner rows are 2 5/16 inches apart and the outer ones 3 5/16 inches. The percentage strength of plate at the joint is 83.72, and the percentage strength of rivets 93.27. All rivets in the boiler are of mild steel of 58,000 pounds per square inch tensile strength and about 48,000 pounds per square inch shearing strength. The girth seams of the shell are triple riveted lap joints, fastened with 1 5/16-inch rivets in 1⅜-inch holes, spaced 4⅛ inches between centers. The percentage strength of plate at these joints is 66.66, and of the rivets 68.6.

The boiler heads are all flanged inwards and joined to the shell with double riveted lap seams fastened by 1¼-inch rivets in 1 5/16-inch holes, spaced 3½ inches between centers. The percentage strength of the plate in the joint is 62.5, and the percentage strength of the rivets 70.15. Each head is in three sections, the tube plate, which is ¾ inch thick, the furnace plate 1⅛ inch thick and the upper portion, which is in the steam space of the boiler, also 1⅛ inches thick. The upper plate is joined to the tube plate with a triple riveted lap joint, fastened by 1¼-inch rivets in 1 5/16-inch holes, spaced 3½ inches between centers, the percentage strength of the plate being 62.5, and of the rivets 70.15. The tube plate is joined to the furnace plate by a single riveted lap joint fastened with 1 3/16-inch rivets in 1¼-inch holes, spaced 2⅝ inches between centers, the percentage strength of the plate being 52.3 and of the rivets 51.6. The furnace holes are all flanged outward, and, of course, the manhole openings are flanged inwards.

The corrugated furnaces are each 7 feet 8 3/16 inches long and 43 inches outside diameter. The inside diameter is 39 inches, and the thickness of the plate ½ inch.

The combustion chambers are all 2 feet 6¼ inches wide, the tube plate being ¾ inch thick and the wrapper and back plates 9/16 inch thick. The bottom of each chamber is stayed by three 3½ by 3½ by ½-inch angles riveted to the combustion chamber, but not to the shell plate. The tube plates just over the furnaces, but below the nests of tubes, are stayed by horizontal angle-bars 4 by 3½ by ⅝ inches, and also by diagonal stays 2 inches in diameter, fastened to the tube plate by means of crowfeet. The sides and backs of the combustion chambers are stayed by ordinary stay-bolts, 1½ inches in diameter at the threaded portion at the end which is reduced to 1¼ inches at the plain portion in the middle. These stay-bolts are spaced



END VIEW OF THE BOILER, SHOWING METHOD OF DRILLING.

6½ by 8¼ inches on the sides and 7½ by 7½ inches on the back. All the bolts are nutted inside and out. The tops of the combustion chambers are supported by girders, four for each chamber. Each girder is composed of two plates 2 feet 6 11/16 inches long, 7¾ inches deep and ¾ inch thick. Each girder has three stay-bolts 1½ inches in diameter, equally spaced in the direction of its length. The girders are in no way stayed to the shell of the boiler.

The tubes are all seamless, cold-drawn steel, 3 inches outside diameter, 7 feet 4⅛ inches long. In each boiler there are 324 plain tubes, No. 8 B. W. G., and 180 stay tubes, No. 6 B. W. G. The tubes are spaced 4¼ inches horizontally and 4 inches vertically.

In the steam space of the boilers there are fourteen through stay rods, each 2½ inches in diameter, besides four diagonal stays 1⅞ inches diameter on each head. The through stays are prevented from vibrating by means of slings from the shell in the middle of the boiler. The portion of the heads between the tube nests is stiffened by two 5 by 4 by ¾-inch angle-bars riveted back to back. The lower part of the heads around the furnace ends is braced by six through stays 2¼ inches in diameter.

There is a 12 by 16-inch manhole in the shell of the boiler, giving access to the steam space, and five 11 by 15-inch manholes in each head in the furnace plate. These manholes are properly re-enforced and strengthened, as shown by the detailed drawings.

Photographs, Figs. 1 and 2, give a good idea of the size of the boilers and the design of the riveted joints, while Fig. 2 shows the method of drilling the furnace ends with a Haesler rotary drill.

THE HEATING AND VENTILATING OF SHIPS.

BY SYDNEY F. WALKER, M. I. E. E.

FANS USED IN VENTILATING.

There are two distinct classes of fans that are employed in ventilation, known as the "propeller" and the "centrifugal" fan. Their names practically explain them. The propeller fan is really a screw, constructed on the lines of the screw propeller of a steamship, and it screws air just as the propeller of a steamship screws water. It will be remembered that with any screw moving in any medium one of three things must move: the screw itself may move on, as where the ordinary wood or metal screw is moved into a piece of wood or metal; the object to which the screw is attached may move forwards, as in the case of many mechanical appliances, and, in particular, in the case of the steamship, which moves through the water as the screw drives it; thirdly, if the screw and the object to which it is attached are both fixed, the medium in which the screw turns must move, and this is what takes place with the propeller fan. As the fan turns it screws a portion of the air from one side of it to the other, just as the propeller of a steamship screws astern a portion of the water in which it is moving. But with air propellers the air only moves. Fans of this kind are available only for moving quantities of air under very low pressure. They do not create any appreciable water gage and cannot work against a resistance. If the air in front of them or behind them is throttled they produce practically no motion in the air. They are of great service for directing air from the outside of a cabin to the inside, or from the inside of a cabin to the outside, and for that purpose they should be fixed in the bulkhead of the cabin, or overhead in the beams of the cabin if preferred. Their office is simply to transfer the air, at a given rate, from the one side of the bulkhead or the beams to the other side. Fans of this type are often used to stir up the air inside of living rooms, saloons, etc., and they undoubtedly do stir up the air, but it can hardly be said that, when used

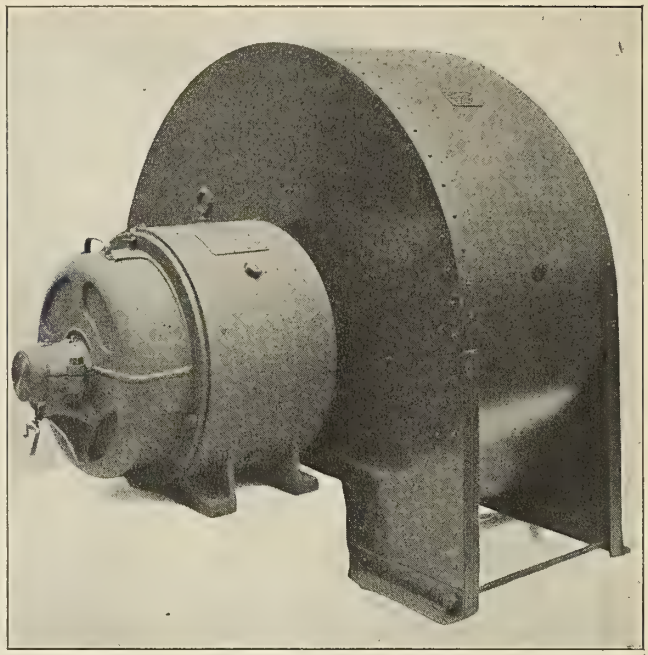


FIG. 68.—STURTEVANT FAN DRIVEN BY ELECTRIC MOTOR.

in that way, they produce ventilation in the proper sense of the term. Churning up the air in a room may tend to assist ventilation to a small extent, but it can hardly be said to produce ventilation itself.

The centrifugal fan works on the same principle as the centrifugal pump. In its simplest form it consists of a number of blades, arranged radially around a central space and fixed between two disks. As the blades are revolved the air in the spaces between them is driven outwards by centrifugal force, a difference of pressure being created between the central space and the periphery of the fan. This causes air to enter the central space, and the air that has been forced outwards to be delivered from the periphery at a certain velocity. Numerous patents for the construction of centrifugal fans are in existence, all designed to increase their efficiency. The simple fan described above is not efficient, because the air between adjacent blades is not simply forced outwards. A portion of it is forced outwards, but other portions form eddies between the blades, the eddies absorbing power from whatever is driving the fan, and reducing the quantity of air usefully delivered.

The various forms of fans are principally on the lines of curvature of the blades, somewhat similar to the curvature of the blades of centrifugal pumps, the object being to eliminate the eddies formed in the air between the blades, to direct the air into the spaces between the blades, and again to direct it

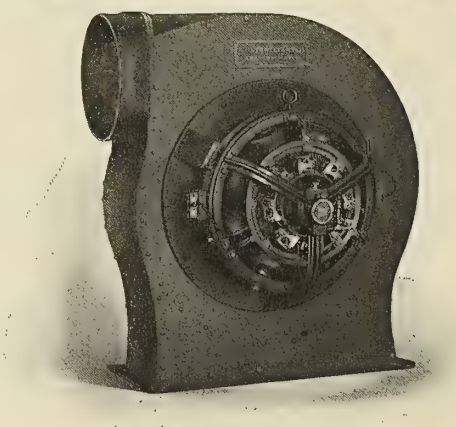


FIG. 69.—STURTEVANT FAN.

out at the periphery of the fan, with sufficient energy to perform the work it is intended for, but with no surplus energy. With centrifugal fans practically any pressure that may be required can be obtained. It is not necessary to mention to marine engineers that air pressure is measured by inches of water gage, but it may be mentioned that with modern centrifugal fans pressures as high as 10-inch water gage have been obtained, and greater pressures could be produced if required. On the other hand, for ventilating purposes, the pressure should be kept as low as possible. As mentioned, at the Birmingham General Hospital the pressure at the fan is only 1/20-inch water gage, but in the great majority of cases pressures from 1 inch and upwards are employed.

Fig. 68 shows one of the Sturtevant Company's* plate fans, constructed for pressure or exhaust. Another type of the same make is shown in Fig. 69. In Fig. 70 is shown a fan built by the Sirocco Engineering Company, New York.

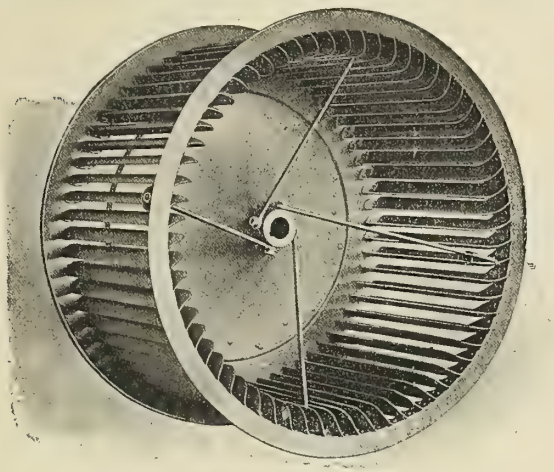


FIG. 70.—SIROCCO FAN.

SIZES OF FANS REQUIRED.

The size of the fans required for driving air through spaces to be ventilated depends upon two quantities: the volume of air to be delivered per minute and the velocity or, what amounts to the same thing, the pressure at which it is delivered. The problem is very similar to that of the chimney for the boiler furnace, and to that of the fans employed for furnishing forced or induced draft. It will be remembered that the sectional area of the chimney must be large enough to accommodate the quantity of hot gases that may have to pass through it when the boilers are doing their hardest work, and it must also be high enough to give the requisite motive column to drive the air and gases through the furnace, flues, etc. Similarly, with forced and induced draft the fans must be large enough to allow of the passage of the air or hot gases through them without throttling, and must be able to produce the necessary pressure to drive them.

With ventilating the same thing occurs. The fans employed must be large enough to allow of the passage through them of the largest quantity of air that may be required, and they must be able to furnish the pressure necessary to drive that quantity of air through the ventilating system.

With the propeller fan, the size of the fan, that which rules the quantity of air it can pass, is its diameter, and the pressure obtained from it depends upon its speed. The pressure obtainable with any propeller fan is very small, and in practice on board ship only very small fans are employed, driven usually by small electric motors, and capable of handling the ventilation of cabins, small mess rooms, or of assisting, or as electrical engineers would say, "boosting," the ordinary ventilating current in saloons, etc. There is a point that may be mentioned in connection with propeller fans, though it will hardly come into the practice of heating and ventilating on board ship. As explained, the propeller blades carry the air from one side of the fan to the other as they move, just as the propeller of a steamship carries the water from one side of it to the other, but while this is true of the outer portions of the blades of the propeller, there is a return air current at the center of the propeller, which may be seen by testing with a ribbon, or something of that kind. This return current, which is in the nature of an eddy, very much on the lines of the eddies that seamen are familiar with in rivers and on the coast, necessarily lessens the efficiency of the fan, and requires more power to be employed in driving it.

With centrifugal fans, the size, in the sense of the ability to accommodate volumes of air, the size which corresponds to the sectional area of the chimney, is the width of the fan, the width between the disks which usually inclose the blades. The wider the fan the larger the quantity of air it will accommodate without throttling. It will be understood that the air passages in a fan offer resistance to the passage of the air through them, just as the passages through which steam passes in doing work offer resistance to its passage, and that this resistance makes a charge upon the power that must be delivered to the fan shaft by the electric motor, or whatever is driving it. Thus a small fan may require a larger power than would be necessary to do the same amount of work in moving the air by a larger fan.

The pressure delivered by the fan varies with the square of its speed. It is not possible to give any rule for the size of fan required for any given work nor the speed, because there are so many fans upon the market, every one of which differs in the pressure it furnishes per revolution and in the capacity for allowing the passage of air.

THE POWER REQUIRED BY THE FAN.

As marine engineers know, power is required to move the air under any given conditions, and it depends directly upon the quantity of air to be moved and on the velocity at which it is moved. Air has weight, and creates friction when moving through pipes, ducts, etc. Both of these features demand the expenditure of energy when the air has to be moved. The matter may be put in another way—the power required depends upon the velocity at which the air is moved and the pressure that is required to move it. In the case of a complete ventilating circuit, from the entrance of a duct leading to a room to be ventilated, to the exit from the duct leading back to the atmosphere, the power required will be measured by the velocity at which the air is moved, multiplied by the difference of pressure between the inlet of the fan and the exhaust of the system. The pressure would be measured, of course, outside of the fan or other apparatus employed to move the air.

It will be noticed that the conditions are exactly the same as in the case of an electric circuit. It will be remembered that the power required in an electric circuit is measured by the current passing in the circuit, multiplied by the pressure required to drive the current through the circuit.

In the case of air, the whole of the pressure employed in the air circuit must be taken into the calculation for finding the power required. Thus, if the air is moving under a pressure of 2-inch water gage, and the duct has an area of 12 square inches, the total pressure will be 24-inch water gage, or a total of 13 ounces; 1-inch water gage it will be remembered, being equal to 0.55 ounce on the square inch. When the total pressure and velocity are known the horsepower in the air is given by the formula

$$\text{H. P.} = \frac{p \times v}{33{,}000},$$

* Hyde Park, Mass.

where p is the pressure in pounds per square inch and v is the velocity in feet per minute. This, however, is the horsepower in the air only, and takes no account of the efficiency of the fan or other losses; and in estimating the actual horsepower required, when the quantities given above are known, it will be wise to double the figures obtained from the last formula.

It was mentioned above that the pressure created by a centrifugal fan varies as the square of the speed. The power absorbed by the fan varies as the cube of the speed. When the speed of a fan is increased two operations take place: the quantity of air delivered by the fan is increased, and the pressure at which the air is delivered is also increased, and hence the cube ratio for the power. When a fan is running, each blade, as it goes around, delivers a certain quantity of air to the duct, or whatever it may be delivering into, and the greater number of revolutions the fan makes the greater is the quantity of air delivered and in exactly the same proportion. The velocity of the air issuing from the fan necessarily varies as the square of the speed of the fan in accordance with the well-known laws.

TESTING THE AIR CURRENT.

In any system of ventilation, or of combined heating and ventilating, it is necessary to test the course of the ventilating

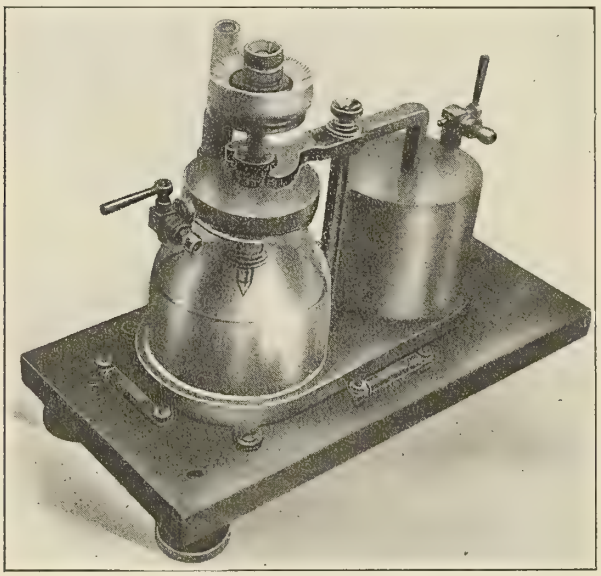


FIG. 71.—THE MICROMANOMETER.

current and also the velocity. The course of the ventilating current can be traced with comparative ease by the use of light pieces of ribbon held on the end of a stick in the air current. The paper windmills that are made for children to play with are also very useful for the purpose, as, if properly made, they are very sensitive. They must be placed, it will be remembered, with their axes facing the direction of the wind, and they will be found to show the direction and a rough approximation of the force of the wind very readily.

To estimate the velocity of the air current an anemometer must be employed. It is an instrument which requires a considerable amount of skill in handling. It consists of a short brass cylinder, carrying what is virtually a small propeller fan pivoted on an axis in the center of the cylinder, and arranged to count up its revolutions on one of the usual dials. The apparatus must be placed so that the fan blades receive the air current in the same manner as an air current would be created by a propeller fan, and the test is made by counting the number of revolutions in a given time.

MEASURING THE AIR PRESSURE.

The simplest method of measuring the air pressure is by means of the apparatus with which marine engineers will be familiar—the water gage—consisting of a U-tube, having water in the bend and arranged for the two ends of the tube to be open to the portion of the air current between which the difference of pressure is to be measured. Measurements of the pressure between the atmosphere and any portion of a ventilating air current are made by allowing one end of the tube to be open to the atmosphere and connecting the other end to the air current whose pressure is to be measured. Water gages are often arranged with one end of the tube bent at right angles, the tube itself being held upon a flat board, very much in the same way as a thermometer is held, and the bent end of the tube being pushed through a hole in the board. A length of india-rubber tube can be employed to connect the ends of the tube with the atmosphere to be measured.

For measuring very small differences of pressure the micromanometer shown in Fig. 71 may be employed. It is claimed that readings to 1/2000 millimeter may be obtained.

ESTIMATING THE HEAT TO BE PROVIDED.

In the preceding sections the writer has explained how the heat is delivered from the different appliances to the air of the room, how the air entering a room is heated and how the ventilating current is made use of to heat and cool a room, etc. In a later section he proposes to estimate the probable quantity of heating apparatus and the probable current required to heat a large ocean liner throughout by electricity. Before doing so it will perhaps be as well to consider how the heat that is required has to be estimated.

In the earlier articles it was pointed out that the heating apparatus in a great many cases was left to heat up the room, the saloon, etc., as best it could; and in other cases the air was heated as it entered the room, either by appliances in the room or by appliances placed in the path of the air current. But he has not dealt in detail with the quantity of heat that has to be provided. The conditions, of course, will vary with the different climates a ship may be passing through and with the different times of the year, but the same rules will apply in all cases. It is not sufficient to assume that the air of a room is heated up by the heating appliance and remains heated. This is what used to be assumed in the old days of open fireplaces and natural ventilation.

The modern heating and ventilating engineer carefully estimates the quantity of heat that passes out of the space to be warmed in exactly the same manner as he estimates the quantity of heat that he can deliver to the space through the surfaces of his heating appliances. Evidently there will be two distinct sources of loss of heat in any room to be warmed—the entrance of cold air from outside and the passage of heat, from the room to be heated, through the walls, floors, ceilings, etc. The first source of loss, the entrance of cold air, is exceedingly difficult to estimate for. It is usual to provide against it, as far as possible, by warming the corridors, alleyways, vestibules, etc., and in the present case it will be left out of the calculation, it being assumed that the air of the alleyways, etc., is warmed to a temperature of 10 degrees above that of the outside atmosphere. The heat to be provided then consists of two quantities—that required to raise the temperature of the air and the objects in the room to the desired amount, and that required to replace the heat passing out through the walls, floors, etc.

THE HEAT PASSING OUT THROUGH THE SHIP'S SIDE, BULKHEADS, ETC.

It will be understood from what has been said with regard to the passage of heat from a higher temperature to a lower,

that the rule given as to the passage of heat from a heating appliance to the surrounding air applies equally to the passage of heat from the air in a stateroom to the water outside the ship, or to the air on the other side of the bulkheads, the other sides of the deck, etc. That is to say, the passage of heat through the ship's side, the bulkheads, etc., will be in direct proportion to the difference of temperature between the inside of the stateroom and the water or air on the outside of the ship or the bulkhead, in direct proportion to the surface exposed to the action and to the thermal conductivity of the substance of which the walls of the stateroom are composed. The heating appliance, whatever it is, must deliver heat to the stateroom at the same rate as it is carried off.

Assuming the temperature of the stateroom to be maintained at 70 degrees F., the temperature to be worked to outside the walls of the stateroom is evidently the lowest that is likely to be met with during the ship's voyage, and this will vary with the climates into which the ship goes and with the seasons. Whalers and sealers, and ships which go into the very cold regions in the neighborhood of the Arctic circle, will be subject to very low temperatures, while those which are engaged in the bulk of the ocean traffic, crossing the Atlantic and the Pacific in various directions, will not have such wide variations. In the calculations which follow, a minimum temperature of 30 degrees F. is taken for the sea and 40 degrees F. for the air outside of the staterooms, with the proviso that for ships in which lower temperatures are met with, these lower temperatures must be substituted in the calculations. It is also assumed that the air in the alleyways, corridors, and generally between decks, will be warmed to a temperature 10 degrees above that of the outside atmosphere.

In houses in Canada and America, that are subject to very low temperatures in winter, it is usual to raise the temperature of the halls, passages, etc., to very nearly that of the living rooms, as serious colds might be taken if this were not done. Also, in the case of institutions in the United Kingdom, such as hospitals, hotels, technical colleges, etc., that are warmed and ventilated on the plenum system, the temperature of the corridors, passages, etc., is practically the same as that of the wards, coffee rooms, class rooms, etc.

Take a stateroom having a cubical capacity of 1,100 cubic feet—this figure is taken to simplify calculations—the dimensions being 12 feet long (fore and aft) by 11½ feet wide and 8 feet high. The surface exposed to conduction from the air of the room to the water outside will be 96 square feet, and that exposed to the air, either of other staterooms or of corridors, etc., will be $8 \times 35 = 289$ square feet. The surfaces of the decks, above and below, will be $2 \times 138 = 276$ square feet.

We may consider that the 96 square feet of the ship's side is subject to a difference of temperature of 40 degrees F. Iron has a conductivity, according to Box, of 233 British thermal units per square foot per hour per 1 degree F. It will be seen, if the stateroom is not lined with wood on the ship's side, how enormous will be the transference of heat from the air of the room through the ship's side to the water. Under the conditions given above the quantity of heat passing out would be over half a million units per hour, requiring a very large heating apparatus to replace it. Incidentally, this shows the difficulty of warming parts of the ship where the naked side plates, etc., are exposed to the water on one side and the air of the ship on the other in very cold climates, and the advantage of wooden ships, in this respect, in cold climates.

A study of cold-storage methods enables the problem to be very effectively dealt with, and the passage of heat from the staterooms, saloons or any part of the ship to be effectively prevented. A lining of wood is in itself effective, because wood has a conductivity, according to Box, in the neighborhood of 0.8 unit per hour for a thickness of 1 inch, and if the wood lining is so arranged as to inclose a small air space between itself and the ship's plates, and more particularly if the air space is divided up into small spaces, so that convection air currents shall not have much room to circulate, and if the wood lining is thoroughly dry, the leakage of heat from the staterooms or saloons, under these conditions, may easily be reduced to 0.5 unit per hour per degree F. difference of temperature for each square foot of surface of the room all over.

Taking the dimensions given above, the total surfaces equal 652 square feet, of which 96 square feet will be transmitting 1,920 units per hour, and the remaining 556 square feet 8,340 units per hour, making a total of 10,260 units per hour, which would lower the temperature of a room of the size given 9.3 degrees F. per hour, unless it was replaced from a heating appliance.

With electrical apparatus this means that 3,000 watts must be delivered to the heating appliances, and this would require three of the usual four-lamp luminous radiators, one non-luminous radiator of 3,000 watts, two of 1,500 watts each, or any other equivalent. With hot water or steam, taking the rate given above of 1.5 heat units liberated per square foot of heating surface per degree F. difference of temperature, and assuming the hot-water apparatus to have a temperature of 170 degrees, 10,260 heat units would require approximately 70 square feet of heating surface. With steam at 210 degrees the heating surface would be approximately 50 square feet.

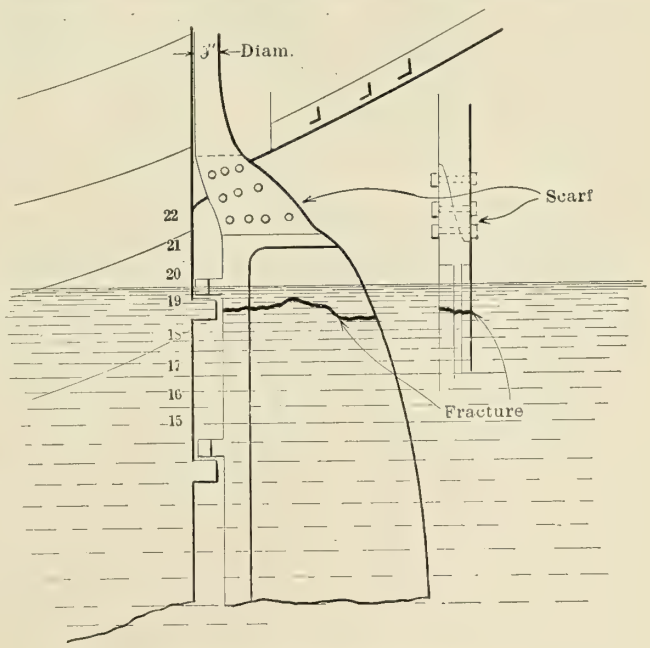
In the estimate for heating an ocean liner entirely by electricity the calculations have been made on these lines, the surfaces through which heat passes out being estimated, and the quantity of heat calculated from the differences of temperature, etc.

(To be Concluded.)

A Fractured Rudder.

The French steamship *Breiz Huel* broke her rudder, which was repaired at Fayal by means of a strap bolted across the fracture at the top and bottom. This, however, was carried away, and the break was renewed about as shown in sketch. After drifting for ten days, the ship was taken in tow by the British steamer *Sidra,* and after six days of towing reached Bermuda late in April.

The stock of the rudder was of cast steel, and the break occurred just under the upper pintle. After being surveyed in Bermuda the vessel left under her own steam for New York.



FRACTURED RUDDER OF THE BREIZ HUEL.

towing the tug *M. E. Luckenback* as a rudder. Repairs were finally completed in the Erie Basin, South Brooklyn.

The *Breiz Huel* is a steel screw steamer of 2,932 tons net and 5,097 gross, built in 1903 by the Chantiers de la Loire, at Nantes. She is 390 feet long, 50 feet broad and 26 feet 3 inches deep. She has seven watertight bulkheads, and is fitted for water ballast. Her triple expansion engine has cylinders 25, 42½ and 68½ inches in diameter by 44 inches stroke. The indicated horsepower is 2,200. Steam is furnished by three single-ended Scotch boilers.

The *Sidra* is a steel screw steamer of 2,033 tons net and 3,145 gross, built in 1893 by Irvine & Company, West Hartlepool. She is 322 feet long, 41 feet 7 inches broad and 21 feet 2 inches deep. She has web frames and five watertight bulkheads, and is fitted for water ballast. Her triple expansion engine has cylinders 23½, 39 and 64 inches in diameter by 42 inches stroke.

The *Breiz Huel* had another mishap late in August, having gone ashore near Aden. After removing 500 tons of cargo, she was floated without having sustained serious damage.

W. B. Smith.

THE WEIGHTS OF VESSELS.

BY ARTHUR R. LIDDELL.

The *Lusitania* and *Mauretania* are in some quarters being decried as monstrosities of naval architecture, which have indeed broken the Atlantic record at enormous cost, but which no ship-owning company, bent on earning profits, will ever attempt to rival. It is pointed out that the weights of vessel, machinery and fuel are such that the carrying of cargo becomes impossible, while the possible receipts from the passenger traffic are not sufficient in themselves to pay the expenses of working.

It is perhaps worth considering in what way the weights of such vessels might be reduced, and how possible reductions might affect the general design.

At the International Engineering Congress, held at Chicago in 1893, the late Direktor Middendorf, of the Germanischer Lloyd Classification Society, read a paper on *The Strength of Vessels,* which received less attention than it deserved. The paper contained detailed calculations of the reduction of the general scantling of a vessel's hull which the fitting of a central lattice girder would render justifiable. The value of the method was testified to by the president of the Congress (Engineer-in-Chief Melville), but copies of the paper not being in the hands of the members until the meeting began, no one was in a position to discuss it.

It may be premised that in his younger days Herr Middendorf had been well known as a capable shipbuilder, and had also himself built bridges and studied the theoretical principles underlying their design, so that his proposals, borrowed from bridge practice, must be taken with all seriousness. His contention was that a properly designed lattice girder at the center line of a vessel would take half the longitudinal strain usually borne by the sides of the structure. Detailed calculations of the strains and the necessary dimensions of the different members of the lattice girder were given by him for a twin-screw vessel of about 400 feet in length. The weight of the girder was 43 tons. On the strength of this Herr Middendorf advocated a reduction in the side plating of from 15 to 20 percent, which, as he showed, would still leave the longitudinal structure stronger than before.

The inconveniences attaching to such a girder were stated to be the necessity of fitting side hatchways, and the circumstance that the diagonal bracing might in some cases interfere with passenger accommodation and with the stowage of cargo; but none of these can be considered to be fatal objections.

If it be assumed that of the thickness usually given to the shell of a vessel, about half is required to meet longitudinal strains of the general structure, and half to meet local pressure of the water, blows of the sea, etc., which may act at the same time, it would appear that a possible reduction of one-quarter, or, roughly speaking, 70 to 80 tons, might be made in the sides in return for a weight of central girder of 43 tons. This latter weight is probably considerably overestimated, inasmuch as the strains due to water pressure and blows of the sea ought to have been deducted from the total to which the longitudinal structure was assumed to be subject.* The gain would here be about 50 tons, or, roughly speaking, about 2 percent of the whole weight of the hull on the shell plating alone. Probably other parts, such as keelsons and stringers, might be reduced as well.

A further means of lightening the hull consists in the general adoption of the system of widely spaced pillars and girders, from bulkhead to bulkhead, at the heights of the

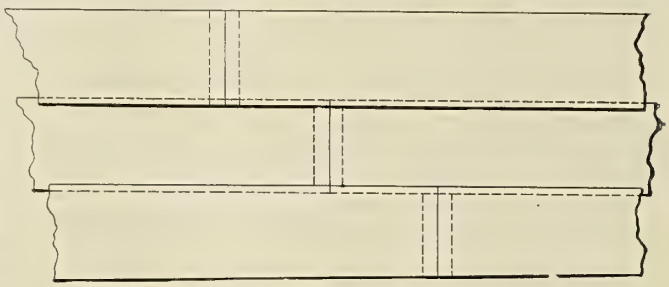


FIG. 1.

decks. This system saves weight in itself, but, when the spans of the beams are thus shortened, the latter may fairly be correspondingly reduced in section, and additional savings of perhaps 2 percent on the weight of the hull may be effected.

In regard to the framing of a vessel, it is by no means certain that the greatest possible lightness has as yet been attained. A judicious use of longitudinal girders and web frames, to take the main strains, combined with frames of reduced section spaced closer together, to withstand the local pressures on the shell, would no doubt result in a saving—it might be at the expense of space.

Another direction from which a saving in weight may come is that of the riveting. The hull of a vessel is constructed, to a considerable extent, of longitudinal strips of steel riveted together at their edges. The expanse of plating, shown in Fig. 1, represents three strakes of shell with butts shifted in the ordinary manner.

When two strips of plating of the same dimensions, the one with and the other without a butt, are severally submitted to tensile strain and tested to destruction, it will, as a rule, be found that the butt will open sufficiently to crack the paint and cause slight permanent set at less than half the strain which the plain plate will bear without rapid extension or "flowing" of its material. In fact, for practical purposes the butt is rather less than half as strong as the plate.

When several strakes are worked together, as in Fig. 1, the conditions become somewhat different. The rivets in the butt are very much more elastic than the plate material, and the result of this is that, when the three strakes have been submitted to tensile strain until the plates begin to slide over one another at the butts, and the paint cracks, the full plate of each of the two strakes adjacent to the butted one begins to be more severely strained in way of the butt than elsewhere. The tendency will be for the butt to open in the middle, while at

* The calculation was based on the assumption ordinarily made, that when a vessel is "at rest" upon the crest or in the trough of a high wave, the bending moment is nearly equal to the total stress which the material, as disposed, can withstand; *i. e.*, when the parts farthest from the neutral axis are strained to their uttermost.

its top and bottom it will remain comparatively unstrained, but the adjacent strakes will be strained to a correspondingly increased extent.

Assume the strain which the butt will just bear without opening to be represented by 1, when the strake is unsupported at the sides. In the case of the three strakes assumed above, the strain on the material of the full plate at each side would then be 0.5, were it not that the butt at top and bottom is prevented from yielding. As it is, the full plate has to do a considerable share of its work. An exaggerated picture of what occurs is given in Fig. 2.†

The butt does perhaps five-sixths of its own work, *i. e.*, the strain taken by it is represented by $5/6 \times 1.0 = 0.833$. The remaining 0.167 of its work is borne by the full plates of

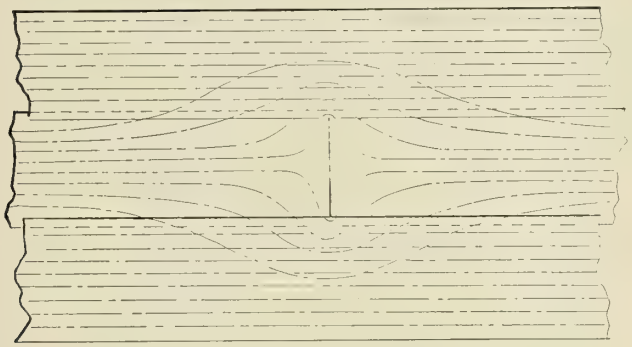


FIG. 2.

Referring again to Fig. 2, it will be evident from the examination of the lines of flow there indicated, that the relatively severe strain of 1.0 borne by the side plates is only local, and might, for the most part, be taken up by a comparatively small doubling fitted to this plate in way of the butt. Meanwhile, the butt connection might taper at top and bottom to about half its width at the center of the butt, or even less. If a butt-strap be adopted, it may perhaps be treble riveted (if necessary) at the middle of the butt, and allowed to taper, first to double, and finally to single riveting at the point on each side next the adjoining strake.

If the suggested doublings were adopted the fibers of the plating would nowhere be strained to more than about half the permissible intensity, while the butt is strained to the full. Thus the plating could be made thinner—perhaps by 25 to 30 percent—provided the butt connections were not reduced in strength. This, however, would mean that in the middle of each butt a larger number of rows of the smaller rivets, suitable for the thinner plates, would have to be made use of. Unfortunately, it is not always an easy matter to increase the number of rows of rivets in a butt connection. To space the rivets nearer together decreases the strength of the plate to too great an extent. We are then confronted with the problem of how to obtain the necessary strength with fewer rows of rivets, and a possible solution of it is the following:

If a butt be set slanting, say at an angle of 45 degrees with the direction of the strake, the spacing of the rivets, measured square across the horizontal plate, is decreased by about 30 percent, while the number of rivets in a single row is increased by about 40 percent. It becomes possible, then, to get

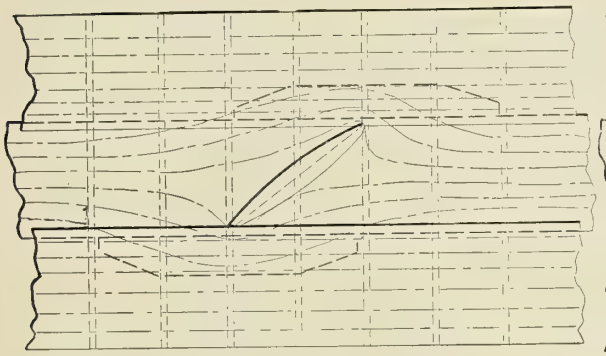


FIG. 4.

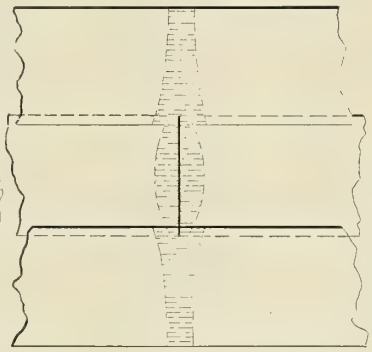


FIG. 3.

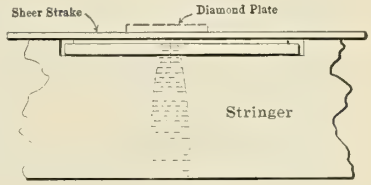


FIG. 5.

the adjacent strakes, 0.083 by each. If, in the adjacent plates taken separately, the solid plate be assumed to be twice as strong as a butt, the fibers of these will be half as much strained as the butt. With the addition of the 0.083 belonging to the butt, the mean stress on each of them increases to 0.583. The stress on one of the adjacent plates, however, is not the same throughout its width. At the side next the butt it may be $0.5 + 0.25 = 0.75$, while at the side away from the latter it may be 0.5.

Inasmuch as the side plates are also pierced at their edges by rivet holes, the strain on their fibers may there rise to 1. Fig. 3 gives a graphic representation of the probable strains to be borne by butt and adjacent strakes.

To take these strains, it is customary to apply to the butt itself a riveted connection which is of equal strength from one side of the plate to the other. In the middle of the plate the connection is just strong enough for its work, while at the sides the strains it has to bear are inconsiderable. Meanwhile the adjacent plates, which do no small share of the work that is credited to the butt connection, receive no further support.

† A strake of topside plating has been known to give way just below a butt of the sheerstrake, leaving the butt somewhat stretched, but still intact.

about the same rivet area into two rows as can be put into three rows with the vertical butt. Fig. 4 shows an arrangement of this kind, in which the frame crosses the butt in the middle of the strake.

Now it may at once be admitted that such a method of construction introduces complications—that it gives more scrap and more work in fitting plates and arranging rivets—and there would be the cardinal objection to it which is made to every novelty for its own sake; but the reward sought for, of a 20 to 30 percent reduction in the plating of a vessel, is one that is worth a good deal of brain work.

The case of a strake of plating, such as a deck stringer not accompanied by a steel deck, in which the butts are held fast at one side of the plate and not at the other, differs materially from the one above considered.

A graphic illustration of this case may be seen in Fig. 5. The point of greatest strain is not, here, the middle of the butt, but the unsupported end point of the latter, away from the sheerstrake. The butt connection has also to take up a larger part of the strain than that which it would have to meet in a totally unsupported strake of plating.

The proportion of the last-mentioned strain which the butt of a strake of plating has to withstand increases with the

breadth of the strake. Further, the proportion of the same strain which the butt of a strake that is supported at one edge only has to take up is probably about the same as that in a strake supported at both edges, and having twice the breadth of the one supported at one edge only.

It follows, then, that a stringer that is without support, or that is only weakly supported at one of its edges, must have stronger butt connections than one which is strongly held on both edges. This explains the circumstance that the stringer plate is apt to give trouble at the butts sooner than the sheerstrake, even when it has the stronger butt connections of the two. The sheerstrake is strongly held within the upper quarter or third of its breadth by the stringer plate and angle. In way of a butt of the former, the unsupported breadth of the plate is also less than in the other strakes of plating of the vessel.

A suitable butt connection for a stringer plate supported at one edge only would be one having several rows of rivets at the unsupported side, and perhaps one row of rivets at the edge next the sheerstrake. The sheerstrake might suitably have short, diamond-shaped doublings in way of the butts of the stringer, where it is subject to extra straining in the manner shown above in connection with Fig. 2.

A longitudinal construction, such as was at one time advocated on theoretical grounds, is attended with drawbacks, not the least of which is that the present convenient method of setting up each frame in place and hanging everything else upon it, so that shoring and scaffolding are minimized, would have to be given up. One advantage which it might be made to yield would be the succoring of the butts of the shell plating in the middle, so that their connections would withstand greater strains without slipping, as above illustrated. It is true, the inner edges of the longitudinals would have to be strongly succored by angles or otherwise, but this would present no great difficulty.

There is another kind of butt connection occurring in floor plates, web frames, etc., which have to take strains applied at right angles to their breadth. For these, the ideal butt connection is one with several rows of rivets at each edge of the butted plate, and perhaps a single row in the middle. The outline of the riveting then has somewhat the form of an x.

Attention given to the work which the rivets really have to do will enable reductions to be made in the weight of rivets and plate overlaps, and in the cost of riveting, but the chief gain is an indirect one, in that it becomes possible to lighten the plating required to provide a given strength.

Much may also be done to reduce the strains on the longitudinal structure by a judicious distribution of the weights, so that upper or lower parts of the girder are not subjected to a constant strain, to meet which one-sixth or one-fifth of the thickness of the material must be "written off" before account is taken of the moment of resistance necessary to meet the effects of wave action, blows, and water pressure, usually provided against. If a vessel could be so designed that the most favorable possible distribution of her weights were always preserved, there is no reason why a reduction in her structure should not be made on this account also.

A somewhat heavy item on a fast passenger steamer is the luggage. Why should not some of the heavy luggage be sent by another and slower vessel? Why should not the space thus set at liberty be devoted to passenger accommodation? The electric light may have to be in constant use in the space thus utilized during the whole of the passage, but for four or five days the want of daylight may very well be borne.

The employment of oil as fuel, and that of explosion motors as propelling machinery, have been much discussed of late, and ideals of this kind may some day be realized. For the present these possibilities are still too remote for serious consideration, but it is evident, in view of the various methods suggested in the foregoing for the reduction of weight, that further developments are possible either in the direction of an increase of speed or in that of economy and consequent reduction in the size of vessel now considered necessary for first-rate Atlantic work.

To sum up, savings may be expected under the following heads:

1. Lattice girder.
2. Longitudinal girders at decks, with lighter beams.
3. Better methods of longitudinal and vertical framing.
4. Improvement in riveted connections.
5. Part of luggage sent by slower vessel.
6. Lighter motive power and fuel.

The savings under heads 1 to 5 may average 2 percent on the displacement, and thus come to 10 percent in all, while that under head 6 may ultimately itself reach 10 percent or more.

But savings in weight may be hoped for from two other sources. One of these is the employment, to a greater extent, of stronger kinds of steel, which, however, is an expensive expedient; the other is the possibility of reducing the proportion of breadth to draft of the vessel. The scantling numbers of the classification societies provide sufficient strength for vessels that are broad in relation to their depth molded and draft of water. If the breadth be reduced and the numbers for the longitudinal and transverse structural parts remain the same (with the exception of that for the beams), the strength provided by these parts will be excessive; for, while the effects of wave action, as regards longitudinal bending moment, vary with the breadth, the moment of resistance of the structure of the vessel, looked upon as a girder, is the more advantageous the greater the proportion of breadth to molded depth. Now a reduction of breadth means a diminution of receipts from the passenger traffic, which is hardly counterbalanced by an increase obtainable in cargo-carrying capacity, and perhaps in relative capacity of the holds; but it is probable that any losses thus sustained will be more than balanced by savings which become possible in connection with the engines, boilers, and fuel.

A Remarkable Motor Boat Race.

On August 3 there took place on Huntington bay, Long Island Sound, an international motor boat race for the Harmsworth trophy, won in Britain last year by the *Dixie I.* The defenders this year consisted of the *Dixie II.*, the *Den* and the *U. S. A.*, while the two challenging boats, both English, were the *Wolseley-Siddeley* and the *Daimler II.* The race, as it finally turned out, was between the *Dixie II.* and the *Wolseley-Siddeley.*

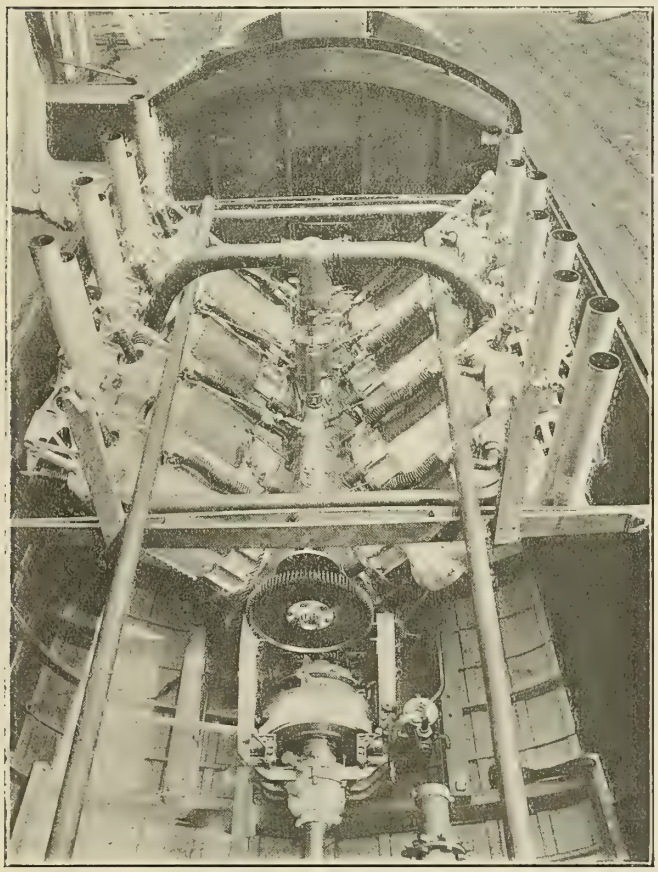
Of the five boats entered the *Diamler II.* was disabled and did not finish. The times for the three rounds of the course of 10 nautical miles (making a total of 30 nautical miles) and the speeds for the various sections of the course and for the entire run are given in the table.

	First Round.		Second Round.		Third Round.		Total.	
	Elapsed Time.	Speed, Knots.	Elapsed Time.	Speed, Knots.	Elapsed Time.	Speed, Knots.	Elapsed Time.	Speed, Knots.
Dixie II.	21.35	27.8	22.16	26.95	21.06	28.4	1.04.57	27.75
Wolseley-Siddeley	22.12	27.02	21.55	27.4	21.39	27.7	1.05.46	27.35
U. S. A.	25.16	23.75	24.59	24.02	24.56	24.06	1.15.11	23.9
Den	26.55	22.28	27.01	22.2	26.51	22.32	1.20.47	22.25

A peculiar feature of the winning of the race was based on the fact that the exhaust pipes of the *Dixie II.* were so low as

to throw a large part of the exhaust gases into the faces of the captain and engineer who handled the boat. Both were seriously overcome by this gas, the engineer having fainted some distance from the finish, and the captain soon after he succeeded in stopping the boat, and just after the committee boat came alongside.

That the *Dixie II.* was not pushed to her limit is shown by the fact that her revolutions were far below that of which she is capable, and by the further fact that in four trials over a measured course of 1.1 nautical miles on the Hudson she has averaged a mile in 1 minute 54.34 seconds, which gives her a speed of 31.347 knots, or 36.049 statute miles per hour. The best record of the *Wolseley-Siddeley* is said to be 30.4 knots, or 34.96 statute miles per hour.



ENGINE OF THE DIXIE II., VIEW LOOKING FORWARD.
(Photograph, Levick, New York.)

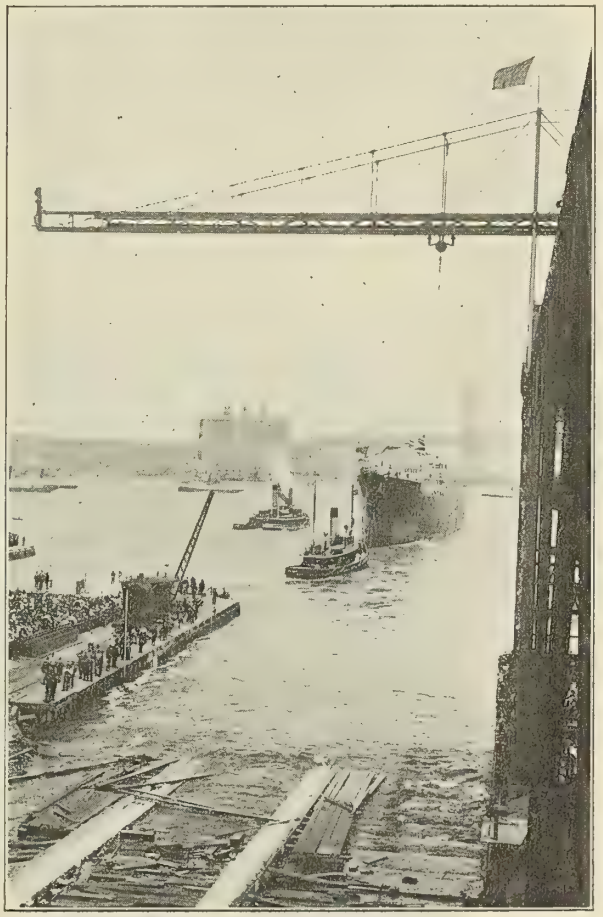
The *Wolseley-Siddeley* has a length of 39 feet 4 inches, a beam of 6 feet and a maximum draft under the propellers of 2 feet 8 inches. The hull is built of timber throughout, with three skins laid vertically, diagonally and horizontally, respectively. The waterlines are straight for a distance of about 12 feet abaft the stem, with considerable flare above to lift the boat in a seaway. The stern has a nearly flat bottom, below which are the two propellers. The displacement of the boat in racing trim is just under 8,000 pounds, of which the machinery accounts for 4,200 pounds. Each of the two engines on the test bench weighed 1,670 pounds. Each has eight cylinders, mounted in pairs. They have developed a total of 460 horsepower at 1,100 revolutions per minute.

The *Dixie II.* has a length of 39 feet 6 inches and a beam of 5 feet 3 inches. The total displacement in racing trim is 4,700 pounds. She was designed by Clinton H. Crane and built by Frank Woods, City Island, N. Y. Her hull is covered with a single skin of mahogany sheathing. There is a 200-horsepower engine, designed for a maximum of 900 revolutions per minute, and operated during the race at about 750 revolutions. The engine consists of eight cylinders, mounted in pairs at 90 degrees, as shown in our illustration. The object of this design was to utilize to the best advantage the space in the boat, and to reduce to a minimum the weight of the crank case, which is said to be not much more than one-half that required for the eight cylinders in a vertical line. The cylinders measure 7¼ by 7¼ inches, and have developed a total of 230 horsepower, the weight of the engine being 2,150 pounds. The propeller is three-bladed, with a diameter of 26½ inches, and a pitch of 49 inches. That a boat with only half the power of her rival was able to triumph speaks volumes for the beauty of her lines and the perfect adjustment of the engine and propeller.

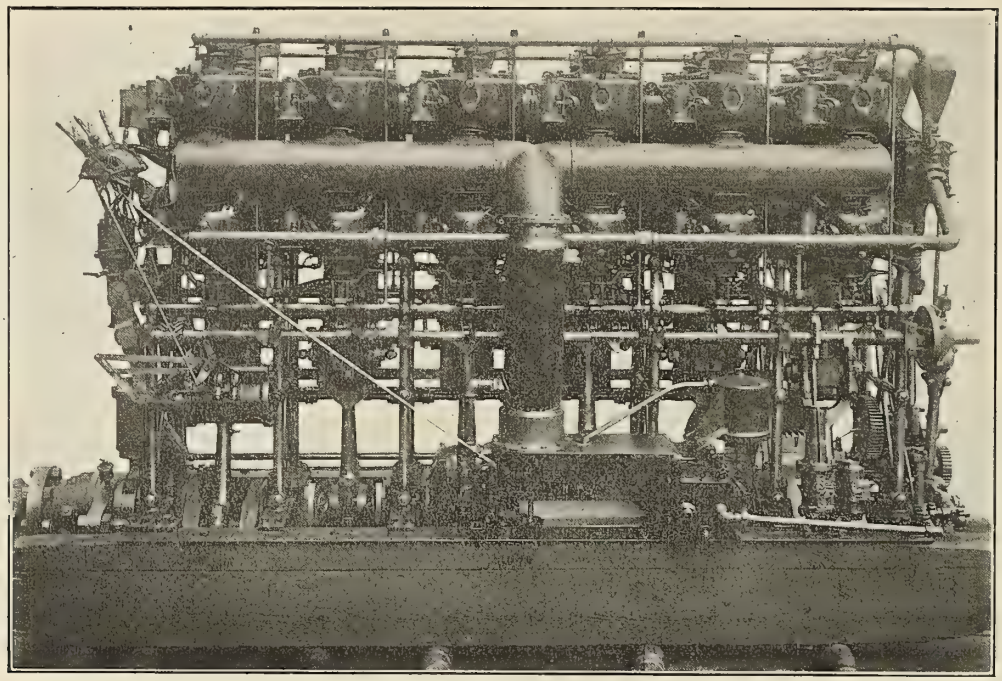
The Navy Collier Vestal.

Last May there was launched from the New York navy yard the first of two fleet colliers building for the United States navy. The *Vestal* has a length over all of 465 feet 9 inches; a length between perpendiculars of 450 feet; a beam of 60 feet 1 inch; a depth of 34 feet, and a full-load draft of 26 feet. At this draft she displaces 12,585 tons, and carries 6,410 tons of cargo coal, besides her bunker capacity of about 1,600 tons.

The ship is to be propelled by twin screws, each operated by a triple expansion engine. With 7,500 horsepower a speed of 16 knots is expected. A battery of four 3-inch rapid-fire guns is provided for protection against torpedo craft. There are four pole masts. The crew will consist of thirteen officers and 163 men. The total cost is estimated at $1,400,000 (£288,000).



THE UNITED STATES COLLIER VESTAL, LAUNCHED AT BROOKLYN.
(Photograph, R. E. Muller.)



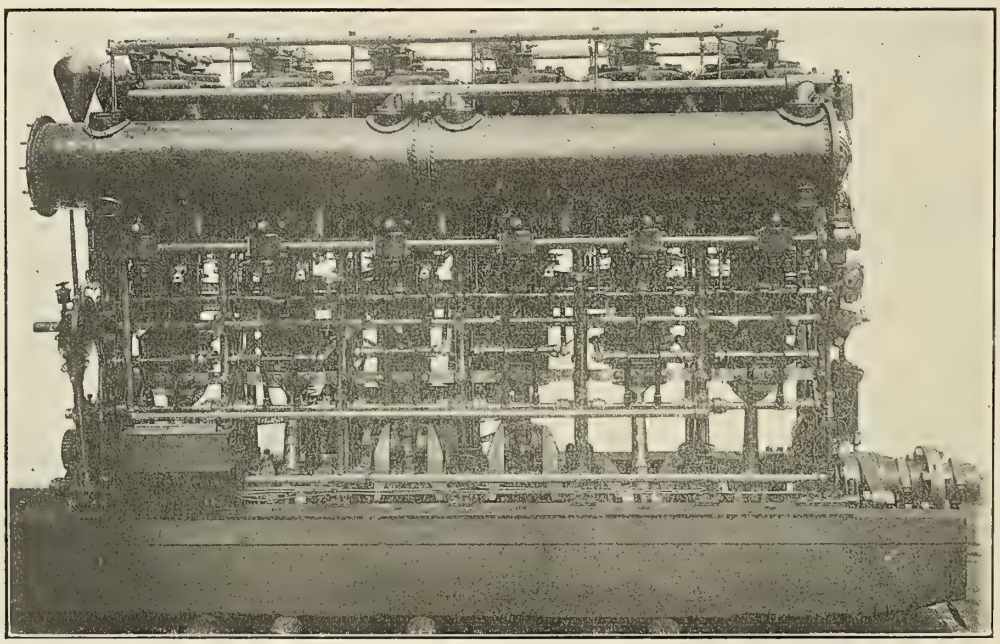
FRONT SIDE OF ONE OF THE AUSTRIAN PATROL BOAT ENGINES.

NEW AUSTRIAN PATROL BOAT ENGINES.

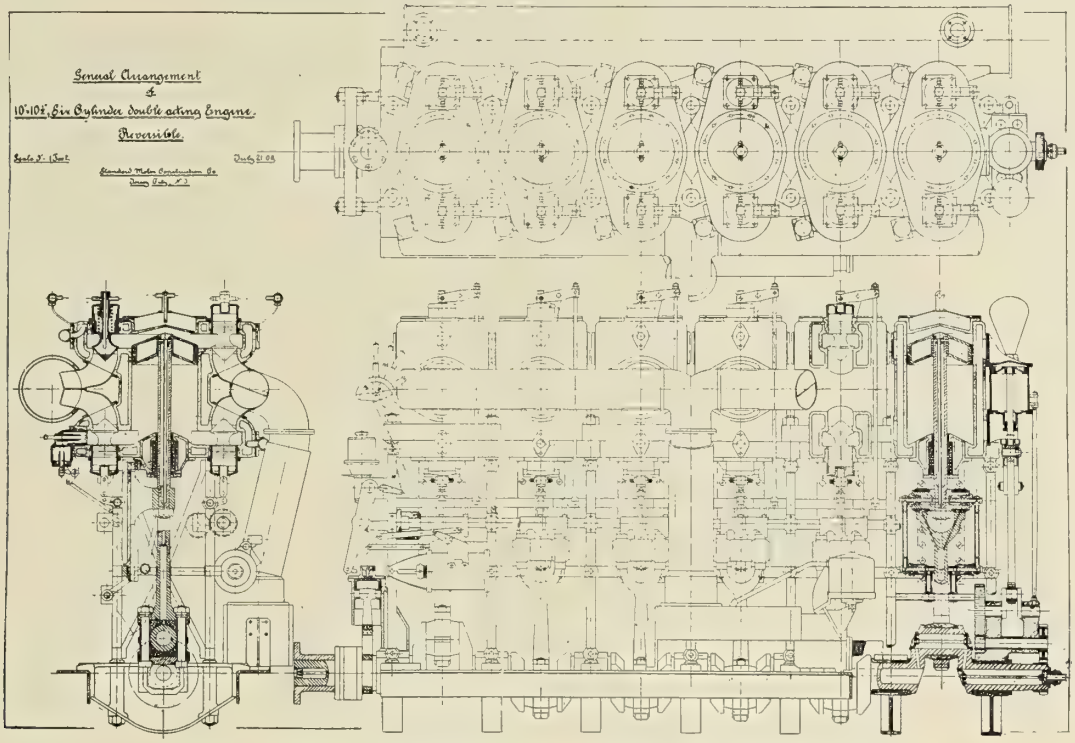
For the propulsion of two patrol boats to be used on the Danube, the Austrian government recently contracted with the Standard Motor Construction Company, Jersey City, for four reversible gas engines, each to develop 300 brake horsepower under constant work at a maximum of 400 revolutions per minute, and to permit a variation of speed down to 90 revolutions. The requirements called for a total weight of not more than 21,500 pounds, including all parts of the engine, and including also 706 pounds of water in the cooling pipes and jackets. The consumption of gasoline (petrol) of 0.72 specific gravity (65½ Beaumé scale) was required to be at full load from 0.3 to 0.32 kilogram (0.66 to 0.71 pound) per horsepower hour; and at half load, 0.38 to 0.40 kilogram (0.84 to 0.88 pound).

To meet these requirements engines have been designed of the six-cylinder, double-acting, reversible type, with shafts turning from upwards to inwards. The cylinders measure 10 inches in diameter, with a stroke of 10½ inches. The crank shaft, with its six cranks, is one solid piece, with a two-inch hole for water circulation, and is set in seven adjustable bearings. The thrust bearing is a roller bearing. The cylinders, piston rods and valves are water cooled. Lubrication is automatic and forced by means of pumps. Carbureters and igniters are of the Standard type, current being supplied from storage batteries.

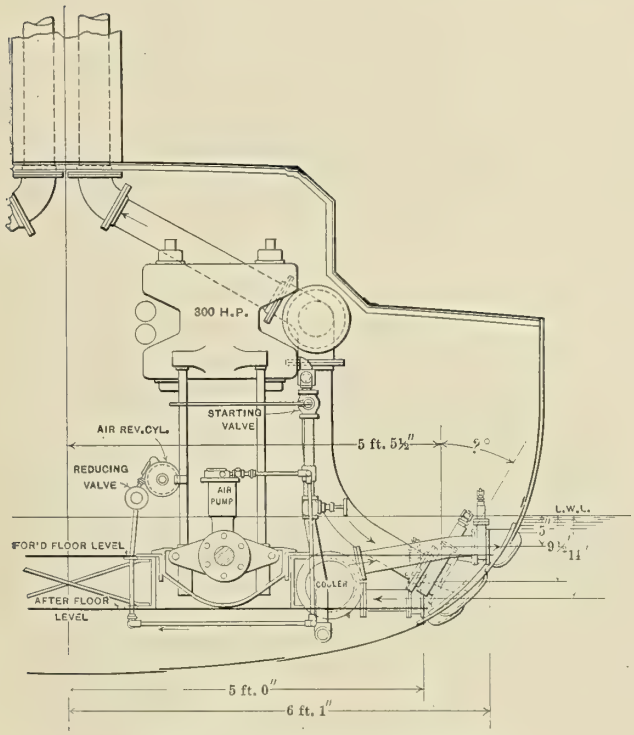
For starting purposes two air tanks, 18 inches in diameter and 96 inches long, serve to accumulate the necessary air and to operate whistles. A sufficient supply of compressed air is held in the tanks to start the engine fifteen or twenty times



REAR VIEW OF ONE OF THE AUSTRIAN PATROL BOAT ENGINES.



GENERAL ARRANGEMENT OF ONE ENGINE, WITH TRANSVERSE AND LONGITUDINAL SECTIONS.



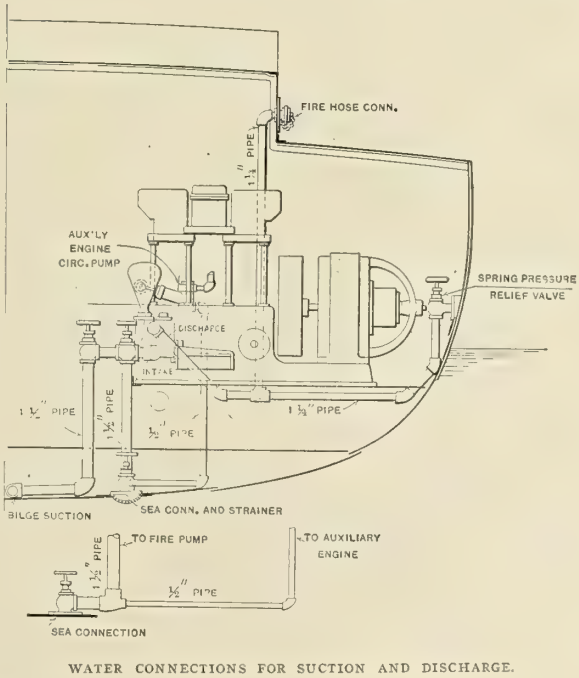
SECTION AFT OF ENGINES, LOOKING FORWARD.

without working the auxiliary air pump. The lowest and highest pressures allowed in the air tanks are, respectively, 7 and 17 atmospheres, corresponding with 103 and 250 pounds per square inch. Auxiliary engines are supplied with a direct-coupled dynamo capable of giving 4½ kilowatts at 65 volts. There is also attached to this engine an air compressor capable of giving pressures up to 250 pounds per square inch. This engine also drives a combination bilge and fire pump. The dynamo serves for charging the batteries for the igniter apparatus, and to light the boat.

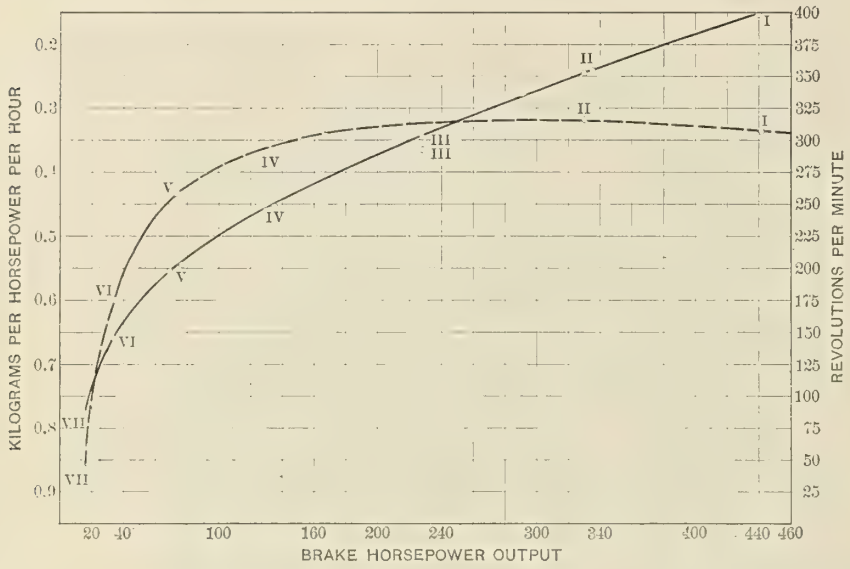
Each engine was subjected to a number of tests, among which was reversing from full speed ahead to full speed astern. This was done in between three and four seconds from the giving of the order, where the contract called for from fifteen to twenty seconds. In each case the engines

VARIABLE LOAD TEST.

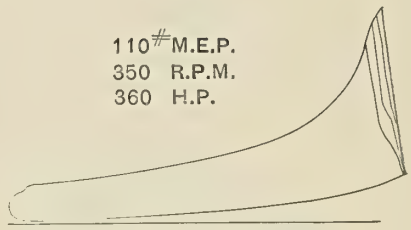
Weight on Scales, Lbs.	R. P. M.	Brake H.P.	Gasoline per H.P. per hour, kg.
1,155	400	441	0.33
985	350	328	0.32
800	300	227	0.36
572	250	136	0.37
355	200	68	0.42
238	146	37	0.6
150	88	17	0.86



WATER CONNECTIONS FOR SUCTION AND DISCHARGE.



THE FUEL CONSUMPTION AT VARYING LOADS ON BRAKE.

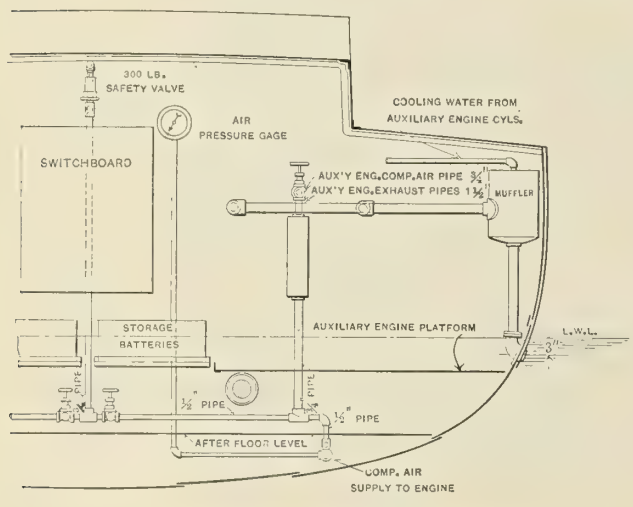


A SAMPLE INDICATOR CARD.

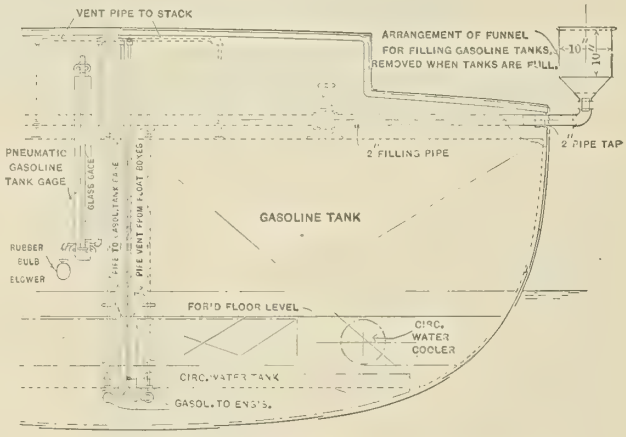
were tested for twelve hours at full load, and were then given tests at variable loads from considerably above the normal to a very low figure, and the tests were successful in every instance. The table for the first engine is representative of them all, and is here reproduced. During the twelve-hour run the load on the brake consisted of 873 pounds at a radius of 60 inches. During the other tests the load was varied considerably, as shown in the table.

TWELVE-HOUR TEST.

Time Taken.	R. P. M.	Brake H.P.	Gasoline per H.P. per hour, kg.
7.15 A. M.	364	303	0.33
8.15	372	310	0.32
9.15	370	308	0.316
10.15	374	311	0.3
11.15	366	305	0.29
12.15 P. M.	372	310	0.29
1.15	368	306	0.3
2.15	368	306	0.29
3.15	365	305	0.29
4.15	368	306	0.29
5.15	374	311	0.29
6.15	368	306	0.289
7.00 P. M.	366	305	0.288
Mean	368.9	307	0.296



AFTER ENGINE ROOM BULKHEAD, LOOKING AFT.



FORWARD ENGINE ROOM BULKHEAD, LOOKING FORWARD.

Notes on the World's Torpedo Craft.

The successful trials of the Laird-built destroyer *Cossack*, which was the first of the big British 800-ton 33-knot class to attain her designed speed, went very far to assure everyone of the probable success of the bigger 36-knot destroyer *Swift*, which was launched in November. The *Cossack* attained 33.1 knots for six hours with some ease, her oil consumption working out slightly below the Admiralty limit. The revolutions on the full speed trial were about 760, the steam pressure on the boilers being about 230 pounds per square inch. All the vessels of this class are criticised for their weak armament—three 12-pounder rapid-fire guns and two 18-inch torpedo tubes. The *Mohawk*,* a sister ship, made 34.3 knots on her official trial, Nov. 5.

The French marine is about to follow the example of the British Admiralty in adopting oil fuel for the new destroyers of the 1907 programme. Three vessels have recently been ordered from Normand, the Chantiers de St. Nazaire-Penhoet and the Forges et Chantiers, at Havre, respectively. They will be about 208 feet long by 21 feet beam, and will displace 440 tons. The speed will be 28 knots, and the vessels will be fitted with Parsons turbines. They will be known as the *Fantassin* class.

The speed attained by *G 137* of the German navy on her recent trials placed her for the time being at the head of the list of fast torpedo craft. In spite of being slightly slower than the larger British vessels her performance of 33.1 knots when

* See page 458, November, 1907, for description.

displacing 580 tons is certainly very creditable, more especially as the other vessels built at the same time failed to attain the guaranteed speed of 30 knots. The German Admiralty lays great stress on strong hulls for all small vessels, and seaworthiness is often attained at the expense of a slightly lower trial trip speed. Twelve destroyers of about 540 tons are now in hand at the Vulkan Works, and should soon be ready for their trials.

Both Spain and Portugal have recently been asking for tenders for torpedo craft. The former government proposes to add to its fleet three destroyers of 350 tons, and twenty-five torpedo boats of 180 tons, the speeds being 30 knots and 26 knots, respectively. The Portuguese inquiry, which was limited to two 350-ton destroyers and six 150-ton torpedo boats, all of 27 knots speed, was probably more widely tendered for than any similar contract of recent years, and the designs submitted varied enormously in almost all details. Turbine machinery is favored by both navies.

Neither Italy nor Russia seems to be adding to the torpedo flotillas at present. The former country has recently completed a satisfactory 370-ton class of 6,000 horsepower, carrying four 12-pounder guns and three torpedo tubes, but in spite of innumerable tenders for all sorts and conditions of boats and destroyers the Russian government has as yet refrained from placing any orders abroad or at home.

The United States adheres to a wise policy in building large and comparatively slow destroyers. They are never likely to be required except in home waters, and the crossing of the Atlantic would be a difficult feat for most of the European boats. The original orders for torpedo craft in the United States some years ago gave builders a considerable amount of trouble, but no difficulty should be experienced with the five new 28-knot boats, which are being built by Cramp & Sons (2), the Bath Iron Works (2), and the New York Shipbuilding Company (1). Ten more are authorized.

Japan builds all of her own mosquito fleet nowadays, but is not at present attempting anything uncommon, though rumor credits her with laying down a 35-knot boat of 1,100 tons.

Chilean and Argentine orders for destroyers seem to have ceased, but a 26-knot boat has just been completed for Brazil by Messrs. Yarrow. This vessel is similar in hull design to innumerable torpedo boats turned out by this firm, but is remarkable for the adoption of a small reciprocating engine in conjunction with Parsons turbines. This system had been practically abandoned by Messrs. Parsons for fast boats, though Rateau is using it in his French destroyer of 7,200 horsepower, now building. Brazil recently ordered several large destroyers from Yarrow, and these are now under construction at the new Clyde works. They will have reciprocating engines. One has already been launched.

No less than four destroyers, built on speculation, were lately lying in English yards awaiting purchasers. Two 25½-knot 570-ton boats were built at Laird's, where they have lain for two years since their trials; they are practically identical with the "river" class destroyers built for the royal navy by that firm. The other two destroyers have been built by Palmer at Jarrow, and have been running trials at intervals during the last twelve months. They displace 400 tons and have attained speeds of 31 to 32 knots. The two Laird boats are fitted with piston engines and the Palmer boats with turbines. Both vessels can carry one 12-pounder and five 6-pounder guns, as well as two torpedo tubes. Two have been bought by the Admiralty, to replace boats lost in maneuvers.

The most interesting feature in the past summer, as far as destroyer work is concerned, was the trials of the *Swift*. This 1,800-ton vessel succeeded in exceeding her speed for the guaranteed period of eight hours, being credited with 38.3 knots.

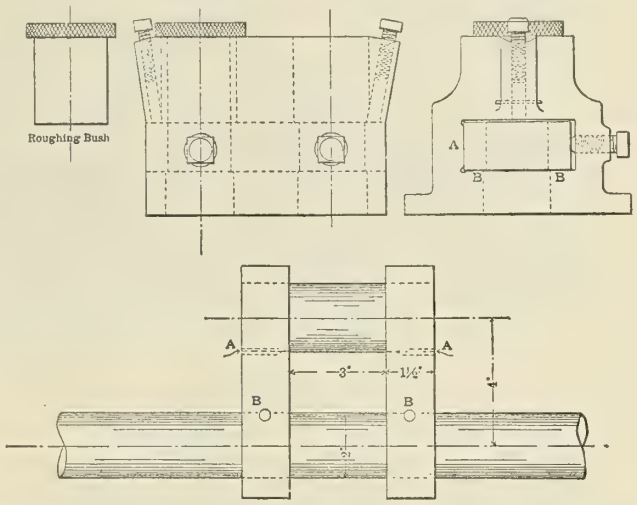
The real problem of the future seems to be one of cost—speed can be attained at a price.

Engine Cranks Built Up Without Turning.

The writer some years ago had a number of small cranks to make for long-stroke steam launch engines, and as these were running at a slow speed, a somewhat novel idea was tried with considerable success. Seeing that *no turning whatever* was done, a remarkably true and satisfactory job was turned out.

The procedure was as follows: Flat steel, 3 by 1½ inches in section, was planed all over, and cut to correct length for the cheeks. Care was taken to keep two edges square, as these were made to register in the drilling jig, which is a strong gray-iron box open at both ends, machined on the bottom and two inside faces, *A* and *B*, at right angles. It is bored to receive a set of drilling and reaming bushes, and is provided with two sets of holding screws at top and side, as shown.

The crank cheeks were inserted one at a time (this was found to make a truer job), with their "*true*" edges bedding against the side and bottom, drilled and reamed to 2 inches, less 0.005 diameter, through both holes for shaft and pin. On



removing them a letter was stamped on the edge bedding on the jig register marked *B*, to insure this face again being used to register when shrinking together.

Bright, 2-inch stock was next selected, which was found to be within 0.0015 inch of round and true. One piece was cut off to length of crankpin, and one piece to total length of shaft over all.

After removing all burrs, the crank cheeks were mounted on the shrinking plate, a gray-iron plate 2 inches thick, with a number of slot holes cast through to receive holding-down bolts. Both cheeks were placed the correct distance apart, and lightly clipped down; the whole was brought over an open fire on the brazing hearth, and the blow-pipe turned into the cheeks and plate until a dull-cherry heat was obtained. The crankpin was then slipped through flush, and as quickly as possible the crankshaft inserted right through both cheeks to the correct distance, and the holding clips released. The shaft end of cheeks was sprayed to induce this end to grip first, when the crank resembled the lower figure.

Holes were next drilled to receive the keys at *A* and *A*, also at *B* and *B*. The shaft keys were put in at right angles, as shown, to facilitate drilling, but if preferred, could have been put in with the ratchet. These keys were also shrunk in place, the crankshaft again being heated for this purpose, and keys lightly driven home. The next operation was to remove the centerpiece between the cheeks. This was done under the cold saw, and the whole polished up and tested for truth.

The objection to this type of crank is, of course, the absence of any radius or fillets at the corners; but this was met,

in the case in point, by allowing a very high factor of safety, with the happy result that no defect whatever showed after being put to work.

These cranks, when tested, showed that unturned cranks *can* be produced; the shaft in this case did not vary more than 0.002 inch out of line—quite as good as a great many turned cranks would be found.—*American Machinist.*

THE STEAMSHIP CHICAGO, OF THE FLEET OF THE COMPAGNIE GENERALE TRANSATLANTIQUE.

THE ATLANTIC LINER CHICAGO.

BY J. G. PELTIER.

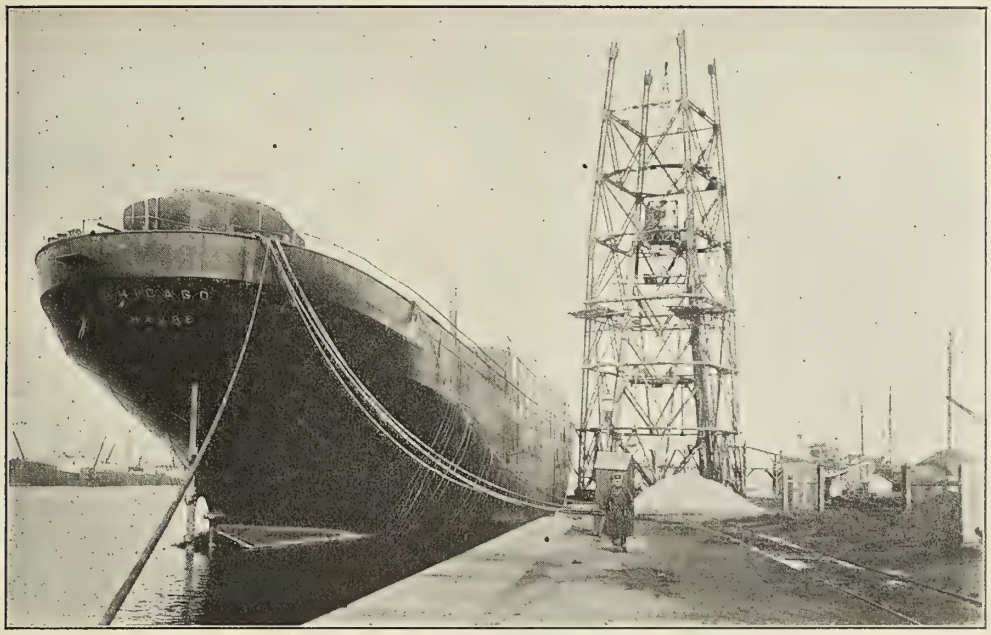
On the 5th of November, 1907, this new twin-screw transatlantic liner was launched from the yards of the Chantiers de l'Atlantique at St. Nazaire-Penhouet. She is now in service between New York and Havre. The ship has the following particulars:

	Meters.	Feet.
Length over all	159.6	523.7
Length between perpendiculars	152.92	501.8
Breadth, extreme	17.6	57.8
Depth (to spar deck)	13.	42.6
Astern draft, fully loaded	7.8	25.6
Displacement, fully loaded		14,500 tons
Gross register tonnage		11,103
Mean sea speed		17 knots
Trial speed (24 hours)		17.66 knots

The hull is of mild steel, giving the highest quotation to the Bureau Veritas; materials have been calculated to give the hull the best strength. From stem to stern the ship is divided into thirteen watertight compartments by twelve watertight bulkheads; these are pierced only by indispensable doors, which number eight. These doors are of the usual patent hydraulic closing type and may be closed from the navigating bridge, if necessary; this gives good security.

There is a complete cellular double bottom from end to end of the ship; this has a total capacity of 1,700 tons of water, which allows good seaworthiness on ballast trim. The double bottom and the different watertight compartments are connected with pumps and pipes, these former being able to discharge 1,385 tons of water an hour, which will be sufficient to maintain the ship afloat under ordinary collision conditions.

THE STEAMSHIP CHICAGO, OF THE COMPAGNIE GENERALE TRANSATLANTIQUE, ALONGSIDE THE PENHOUET WHARF.



THE TRANSATLANTIC LINER CHICAGO, AND THE 150-TON CRANE, UNDER CONSTRUCTION.

There are nine decks, viz., the third, second and first 'tween decks; the fourth, third, second and main decks, the spar deck, the promenade deck and the awning deck. The last two are not the full length. On the awning deck are the officers' accommodations in a large deckhouse. On the promenade deck are the drawing room, the smoking room, the ladies' room and the entrance to the first class accommodations.

On the spar deck is a large deckhouse, 220 feet in length, in which are, from stem to stern, the first class dining-room, numerous first class cabins, bath rooms, children's room, etc. Aft of the large house are two small houses, one for the third class social and smoking room, the other for the steering apparatus, the entrance to the third class and to the steerage passengers' accommodations. In the forecastle are accommodations for the petty officers and stewards.

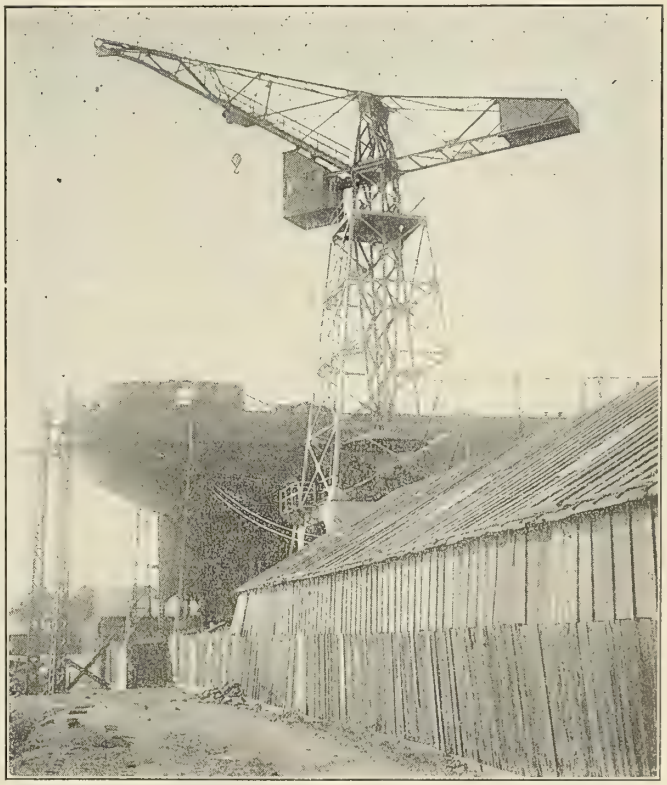
On the main deck are from stern to stem: stewards' and stewardesses' rooms, third class passengers' accommodation, steerage passengers' rooms; in the center, first class passengers' accommodations; in the way of the engines, the engineers' rooms; in the way of the funnels, kitchens, etc., forward are steerage passengers' rooms and crew quarters. There are no passengers of the second class on board this liner.

The first class social hall and others are decorated in the Louis XV. style, as well as the dining room, smoking room and ladies' room. The dining room contains 118 seats, the passengers being accommodated, as usual, by small tables for from two to ten passengers each. The third class passengers' dining room is at same time a social hall and smoking room, and contains seventy-four seats. There are no "cabines de luxe," but there are ninety-eight cabins of first class, 184 of third class, and beds for 1,055 steerage passengers.

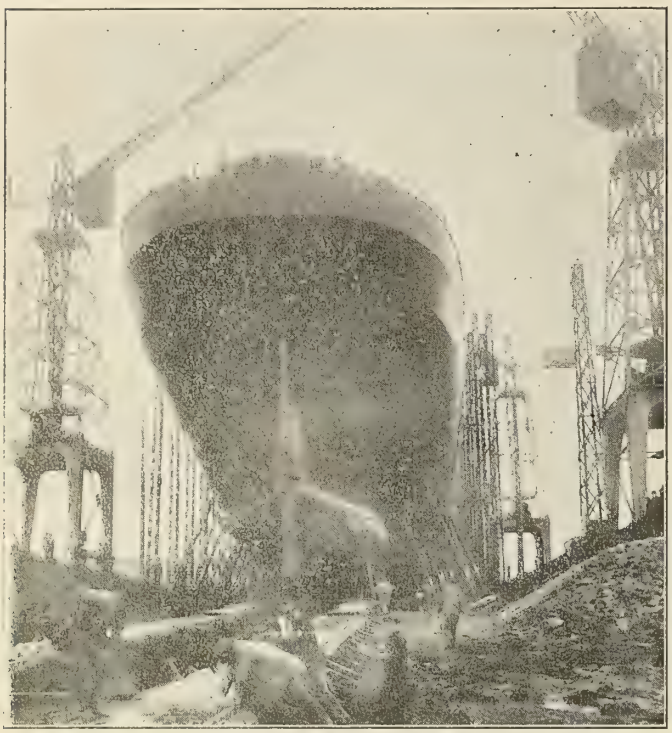
As shown in the accompanying photographs, the lines of this liner are very fine, and as the engines answer to the design, the contracted speed was easily attained on trial trips. All apartments are heated by hot water; the heat may be maintained at a temperature of about 18° C. (65° F.). The ventilation is effected by electricity, and in the first class cabins, each passenger can regulate the ventilation of his own cabin. Numerous bath rooms, fitted with cold and warm water, are at the disposal of the passengers; the wash stands are also supplied with warm and cold water throughout the ship.

The two main engines are of the usual triple expansion type, three cylinders having, respectively, the following diameters: 27, 44 and 74 inches, with a stroke of 54⅜ inches. At ninety-five revolutions per minute, the indicated horsepower is about 9,500. The steam is supplied to the main engines and auxiliaries by nine cylindrical boilers of the marine type, working at a pressure of 193 pounds per square inch. These boilers have a total surface of grate of 575 square feet; the heating surface is of 20,630 square feet. The boilers have twenty-three furnaces and are served by two large funnels.

The use of electricity is considerable. There are two 140-kilowatt (110 watts and 1,270 amperes) dynamos operated by steam turbines. The winches, capstans and boat winches are



ONE OF THE ELECTRIC CRANES USED IN BUILDING THE CHICAGO.



PREPARING THE WAYS FOR LAUNCHING THE CHICAGO.

electrically driven, and, of course, the ship is lighted by electricity. There are also refrigerating engines, having a power of maintaining a temperature of — 5° C. (23° F.) in the cold store rooms. These engines are of the Linde type, operated by duplex engines. The ship is fitted with wireless telegraphy and submarine signaling equipment.

There are sixteen steel boats, of which fourteen are life boats, and five life rafts, fitted with Welin quadrant davits, allowing them to be launched in 40 seconds by four men only, whatever may be the situation of the ship. The crew of this liner includes seventeen officers (deck and engine), 115 men (sailors, stokers, firemen and engineers), and sixty-two stewards and stewardesses. The total number of persons that may be carried is 1,700, all included.

A NEW PATROL STEAMER FOR FISHERY DUTIES.

The twin screw patrol steamer *James Fletcher,* owned by the Lancashire & Western Sea Fisheries Committee, for patrol duties in the Irish Sea and on the west coast of England and Wales, has recently been built by Philip & Son, Ltd., Dartmouth, from the designs of Alexander Richardson, of Liverpool. She is of the following dimensions:

	Feet.	Inches.
Length over all	147	..
Length between perpendiculars	139	6
Beam molded	23	6
Depth molded	13	6
Draft aft	11	..
Draft forward	8	..
Draft mean	9	6

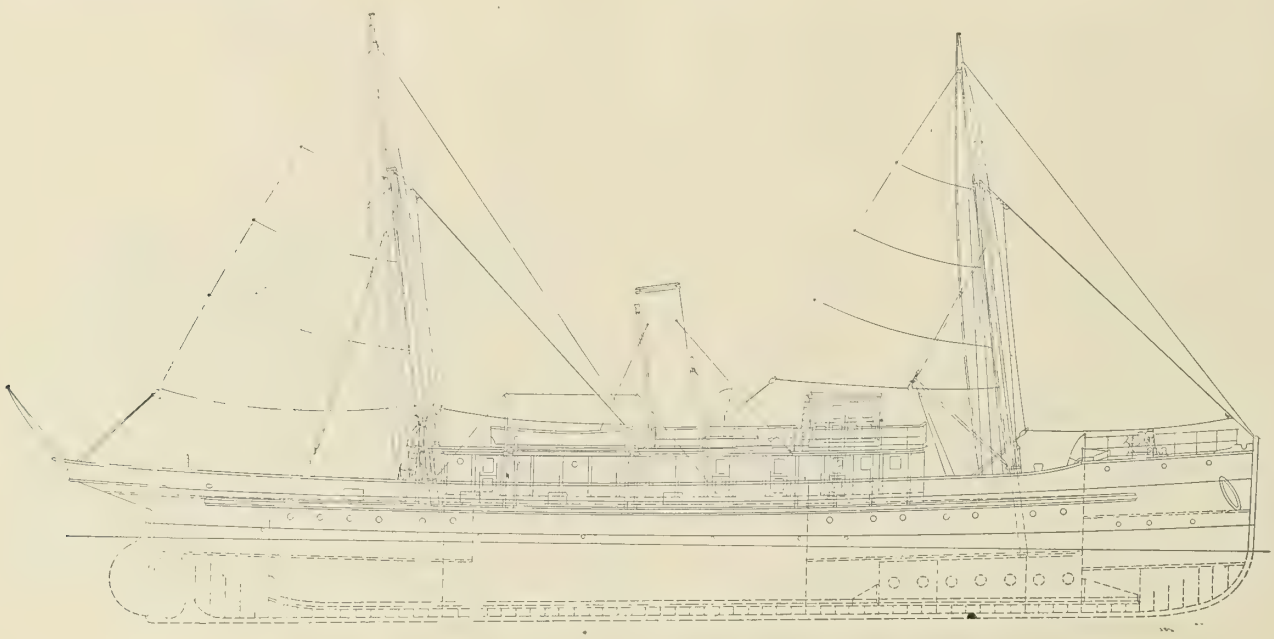
Displacement, corresponding to this draft, 420 tons.

The vessel is built of Siemens-Martin steel throughout, and classed 100 A1 under Lloyd's special survey, and under the Board of Trade rules and regulations with regard to accommodation, tonnage, lights, signals and life-saving appliances.

The stem and heel are of bar iron, 6½ by 1⅜ inches, in long lengths, properly scarfed together. The stern frame is of the best hammered scrap iron, 6¼ by 2¾ inches, and fitted with solid rudder gudgeons, stoppers and heel steps. The rudder is of the single-plate type, with the frame of the best hammered scrap iron. The plate is ¾ inch in thickness and the head is 5 inches diameter. The pintles are of the portable type, 3¼ inches diameter, and the gudgeons in which they work are bushed with hard gunmetal.

The main frames are of angle steel, 3 by 2½ inches by 6/20 inch, extending in one length from heel to gunwale, and spaced throughout 22 inches apart between centers. Floor plates are fitted to each frame, 13 inches deep at center line, tapering to width of frame at the ends. These are 6/20 inch thick forward and aft of the machinery space, 7/20 inch under the engines, and 8/20 inch under the boiler. Reverse frames are fitted to every frame, 2¾ by 2¾ inches by 6/20 inch, increased to 7/20 inch and 8/20 inch in wake of machinery.

There are four watertight bulkheads, each built of 4/20-inch plates on 5/20-inch floor plates, and stiffened with angles 3 by 2½ inches by 6/20 inch. The transom frame and the frames that carry the counter are of 5/20-inch and 6/20-inch plates and 3 by 2½ inches by 6/20-inch angles.



OUTBOARD AND PARTIAL INBOARD PROFILE OF FISHERY STEAMER JAMES FLETCHER.

THE FISHERY STEAMER JAMES FLETCHER READY FOR SERVICE.

The middle line keelson is of bulb plate, 10 inches by 10/20 inch, and 3 by 3 inches by 6/20-inch angles, extending along the top of the floors from the forward to the after bulkheads, to which they are connected by strong brackets. The side keelsons and bilge stringers are each of double angles, 3 by 3 inches by 6/20 inch, extending on reverse frames and lugs, all fore and aft, connected at the stem by strong breasthooks, and well bracketed at the after end of the transom. Intercostal plates 5/20 inch thick are worked between the side keelson angles for three-fourths length amidships. The engine and boiler seatings are very strongly constructed of plates and angles, the main frames and floors being utilized as far as practicable. The coal bunkers are of 80 tons capacity, and are of 4/20-inch and 5/20-inch plates and 2½ by 2½ inches by 5/20-inch angles.

Under the forward accommodations, deep tanks are built in the vessel; they are of 5/20-inch steel plates, and stiffened by 4 by 2½ inches by 6/20-inch angles. This tank is divided into two compartments, the forward part being used as a ballast tank and the after part as a fresh-water tank for reserve feed for boiler.

The main deck beams are on alternate frames, and are of angle steel, 6 by 3 inches by 8/20 inch amidships, diminished to 5½ by 3 inches by 6/20 inch at ends. They have a camber of 6 inches in the full breadth of vessel. The lower deck beams are 5½ by 3 inches by 6/20 inch, and are straight across. The hold stanchions are of solid steel, 2⅜ inches diameter.

The upper deck stringer plate is 24 inches by 6/20 inch amidships, reduced to 19 inches by 5/20 inch at ends, and is connected to the sheer strake by a continuous gunwale angle 3 by 3 inches by 6/20 inch. The lower deck stringer plate is 19 inches by 5/20 inch amidships, to 14 inches by 5/20 inch at ends. A continuous tie plate, 7 inches by 6/20 inch, is worked on the main deck beams all fore and aft in a line with the deck erections. The usual deck plates are fitted on the beams under the windlass, winch and in wake of masts and other erections.

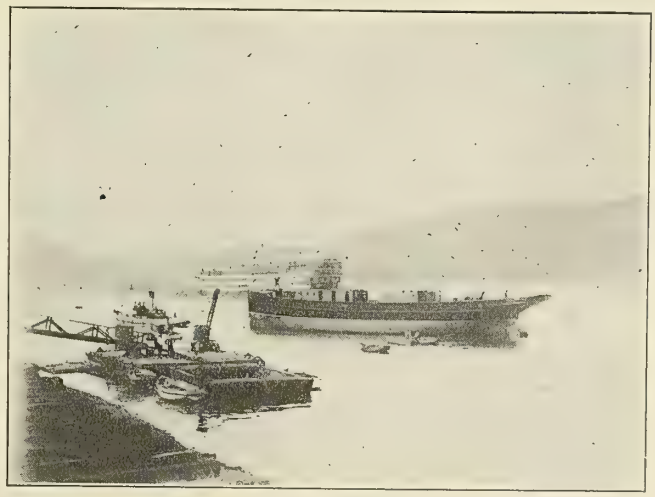
The main deck is of yellow pine, 3 inches thick, with margin planks of teak all around the waterways and deck erections. The bridge deck is of yellow pine 2 inches thick, also with teak margins.

The shell plating includes garboard strake of 8/20 inch thickness all fore and aft, bilge strakes, 7/20 inch to 6/20 inch; sheerstrake, 9/20 inch to 6/20 inch, and the remainder 6/20 inch to 5/20 inch, the thicker plates being for about two-thirds the vessel's length amidships. The bulwarks are of 5/20-inch steel, and surmounted by a rail angle of Tyzach's section. Doubling plates are fitted to the bulwarks in wake of the hawse and quarter pipes, and the bulwarks are stiffened and supported by galvanized wrought-iron spur stanchions, spaced about 4 feet apart. All the fore-and-aft edges of shell plating are overlapped and single riveted, and all the end butts throughout are flush and double riveted, with inside straps.

Bilge keels are fitted on each side for half length of vessel amidships. They are of steel plate, 8/20 inch thick by 12 inches deep, and are attached to the shell by double 3 by 3 inches by 6/20-inch angles.

The deck erections are of 5/20-inch steel, stiffened by angles 3 by 2½ inches by 6/20 inch, these angles being carried across the top, so as to form the beams for the bridge deck. The whole of these plates are flush butted, with external butt straps, fitted so as to form panelling. All the doors in the deck houses are of teak.

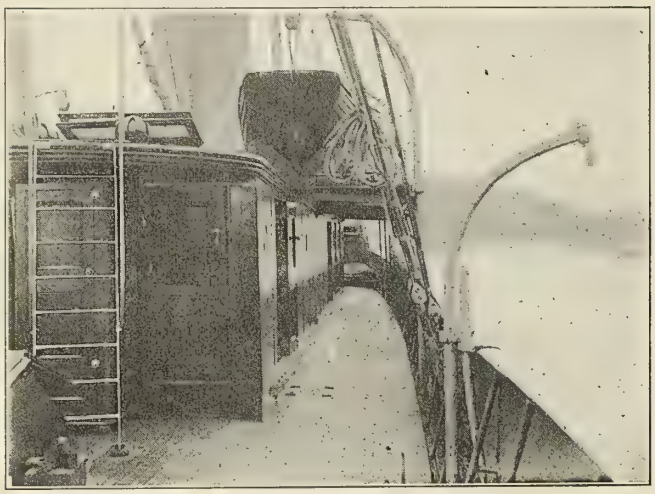
The accommodation on the main deck includes a large and roomy chart house and deck saloon, extra large galley and the usual lamp rooms, toilets, storerooms, etc. This is all forward of the boiler room, but the erections are continued over



THE SHIP AFTER LAUNCHING. IN THE BACKGROUND IS THE NAVAL CADET TRAINING SHIP BRITANNIA.

the stokehold to the after end of the engine room, so as to give ample light and ventilation to these compartments; and the top, from the fore end of boiler room to right aft, is entirely of steel. The wheel house is on the bridge deck, and is heavily constructed of teak. This house contains the controlling devices of the steam steering gear, the latter being placed aft on the main deck near the rudder quadrant.

The deck fittings comprise a powerful steam and hand windlass, with warping ends and the usual compressors and controlling gear fitted on the forecastle head; a steam trawl winch, fitted aft on the main deck, together with the usual arrangements for the beam and other trawling for use in the



VIEW FROM STARBOARD QUARTER, LOOKING FORWARD.

pursuit of the duties for which the vessel is intended. The steam steering gear, trawl winch and windlass were supplied and fitted by Thomas Reid & Sons, Paisley. The exhaust steam of all these is carried to the condenser. All the wood deck fittings, such as skylights, companions, and including the forecastle and quarter decks, are of teak.

Two pole masts of Oregon pine, each in one length, are fitted with the usual standing and running rigging. There are two boats, one 18-foot lifeboat and one 20-foot cutter. Each has a beam of 5 feet, and both are very strongly constructed of teak and pine, and have very ample outfits. The cutter is fitted with air cases similar to the lifeboat.

The bower anchors are of Hall's stockless type, three in number, and each weighing 9½ cwts. The stream anchors are 2¾ cwts., and the kedge 1¼ cwts. These are of the ordinary stock pattern. The cables are stud linked, and measure 165 fathoms, of 1 1/16 inches for the bowers, and 60 fathoms of 10/16 inch for the stream anchors. The hawsers and warps are of tarred manila.

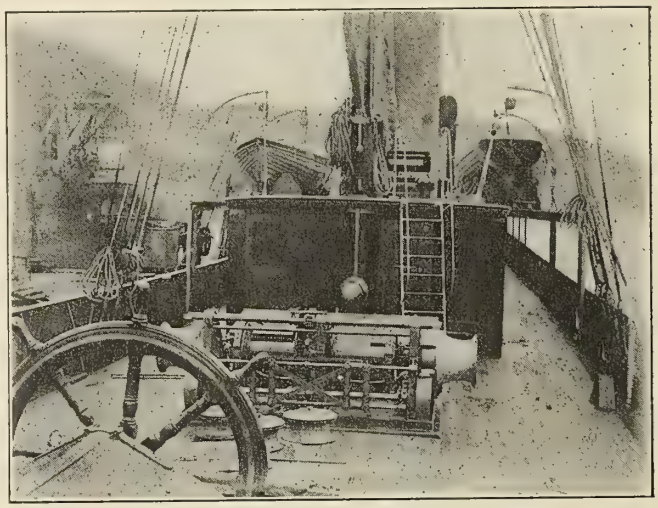
The accommodation below deck, forward, includes four sleeping cabins, saloon, pantry, bath room and toilet. The saloon is fitted in neatly paneled, light polished oak; the sleeping cabins in enamelled pine, with polished teak toppings and nosings. Abaft the engine room are the crew's mess room, captain's, mates', engineers' and stewards' sleeping cabins, and a large and roomy laboratory for the use of the scientist for experimental work in connection with the Fishery Board's duties. The crew's accommodation is right forward in the forecastle.

A perfect system of ventilation is fitted. The whole of the cabins are heated by steam radiators, the steam being led from the main boiler and back to the condenser. A complete system of electric bells is fitted throughout the vessel. The lighting is by electricity, and includes a 5,000-candlepower searchlight, placed on the bridge. The electricity is generated by a direct-coupled steam engine and dynamo, by J. H. Holmes & Company, Newcastle-on-Tyne. A reserve set of oil lamps is also fitted, and the vessel has a complete outfit for both hull and machinery.

The *James Fletcher* is propelled by two triple-expansion three-cylinder surface condensing engines, each operating a three-bladed manganese bronze propeller. The cylinders are 10, 16 and 26 inches in diameter, and have a stroke of 20 inches; the high-pressure cylinder in each case being forward, and the low-pressure aft. Piston valves are fitted to the high-pressure and intermediate cylinders, and double ported D valves with relief rings to the low-pressure. They are all worked by Stephenson link motion, with double-bar links.

The framing of the engines is entirely of cast iron; all the principal rods, shafts and spindles are of mild steel. White metal is fitted to the bottom ends and also to the main bearings. The reversing gear is of the direct-drive steam and hand type, and the whole of the starting valves and controlling gear are handled from one position, so that the whole can be easily operated. The engines were designed to indicate not less than 650 horsepower when working at a boiler pressure of 185 pounds per square inch.

The auxiliary machinery includes an independent condenser, operated by a separate steam-driven centrifugal circulating pump. The suction branch of this pump is connected to the bilges as well as the sea, so that if necessary the bilges may be pumped out by it. A vertical direct-acting duplex donkey or general service pump, with all gunmetal water ends, is fitted; also a Weir feed heater with automatic controlling gear, operating the boiler feed pumps. These latter are in duplicate, of the duplex type, and are direct and double acting. There is also a Downie feed-water filter. The electric lighting plant and the main air, feed and bilge pumps are entirely in duplicate, and are driven direct by a compound steam engine.



LOOKING FORWARD FROM QUARTER DECK, SHOWING STEAM TRAWL WINCHES.

A complete system of piping and pumping arrangement is fitted.

The boiler is of the single-ended return tube type, with three furnaces. It is 14 feet 6 inches in internal diameter by 10 feet long, and constructed entirely of steel, in accordance with Lloyd's rules and regulations, for a working pressure of 185 pounds per square inch. It has ample heating and grate surface for its required duties. The furnaces are of the Morison suspension type, each with its own separate combustion chamber. The stokehold is forward in the ship, the back end of the boiler being against the fore end of engine room. The weight of the boiler empty is 41 tons, and with steam up 59½ tons.

The speed of this vessel on her trial trip was 12¾ knots, and the indicated horsepower 660; a result very satisfactory to both builders and owners.

THE STEAMER DYNAMO, WHICH RAN INTO AND SANK THE TRAWLER QUAIL.

Collision of the Dynamo and the Quail.

The Wilson liner *Dynamo* and the steam trawler *Quail* collided in the Humber river early on Aug. 19. The *Quail* was one of the unfortunate vessels damaged by the Russian Baltic fleet in 1904. In the present instance she was struck on the starboard side aft, and sank very rapidly. The liner sustained very little damage. Two men were drowned, but the rest were saved by the boats of the *Dynamo*.

The *Dynamo* is jointly owned by Thomas Wilson, Sons & Company, Ltd., Hull, and the North Eastern Railway Company, Ltd. Her gross tonnage is 504 and net 311. Her dimensions are: Length, 175 feet 7 inches; beam, 25 feet; depth, 13 feet 8 inches. She had a previous accident, having struck on the Jarding Rocks June 8, 1906.

THE STEAM TRAWLER QUAIL, WHICH WAS SUNK THROUGH COLLISION WITH THE DYNAMO.

The *Kaiser Wilhelm II.*, in August, steamed from Sandy Hook to Eddystone lighthouse, 3,008 nautical miles, in 5 days 9 hours 55 minutes. The speed was 23.71 knots.

A Quick Method of Repairing a Broken Shaft.

BY U. S. C. E. MEIGS.

The writer recently, almost by accident, hit on a method of repairing a broken shaft, so cheap, so quick, and so surprisingly strong that he thinks it may be of service to your readers. The use of the method would often obviate a long and expensive delay and loss of work, for the shaft gives nearly as good service as before it was broken.

The writer has under his charge a hydraulic dredge used on the Mississippi river improvements in the vicinity of Keokuk, Iowa. This dredge is driven by a compound high-pressure engine, with cylinders 14 and 24 inches in diameter by 15-inch stroke, running 220 revolutions per minute and developing about 250 horsepower. The steel shaft of this engine, 6 inches in diameter, broke about 10 inches from one of the cranks.

The cranks are quartering, and the shaft is a highly finished one that takes a long time to build, even under the

best of circumstances. It was, as you can see, a difficult task to weld this shaft so as to repair it, as the stub-end was so close to the crank that to heat it sufficiently was likely to warp the latter out of shape and spoil the whole shaft. The attempt was made, however, and the shaft promptly broke again at the same place, although a whole week and a large expense had attended the effort to put the shaft in working condition.

At the suggestion of a traveling engineer, we simply squared the two broken ends and screwed them together with a stud that went half into each piece of shaft. Squaring the ends shortened the shaft some six inches, but this could be remedied by moving in the outboard pillow block. A chunk of soft and tough steel, that had once done duty as a wristpin for a large engine, was selected from the scrap pile. This was cut off 10 inches long and turned to 4 inches in diameter; it was then threaded the whole length with a screw of four threads to the inch; each piece of shaft was then bored and threaded to fit this screw, and when finished the stud was screwed into one piece of shaft, and the other piece screwed home. To make the job a little more solid, the stud was dipped into salt and water to make a rust joint of it, and keep it from coming unscrewed by any chance.

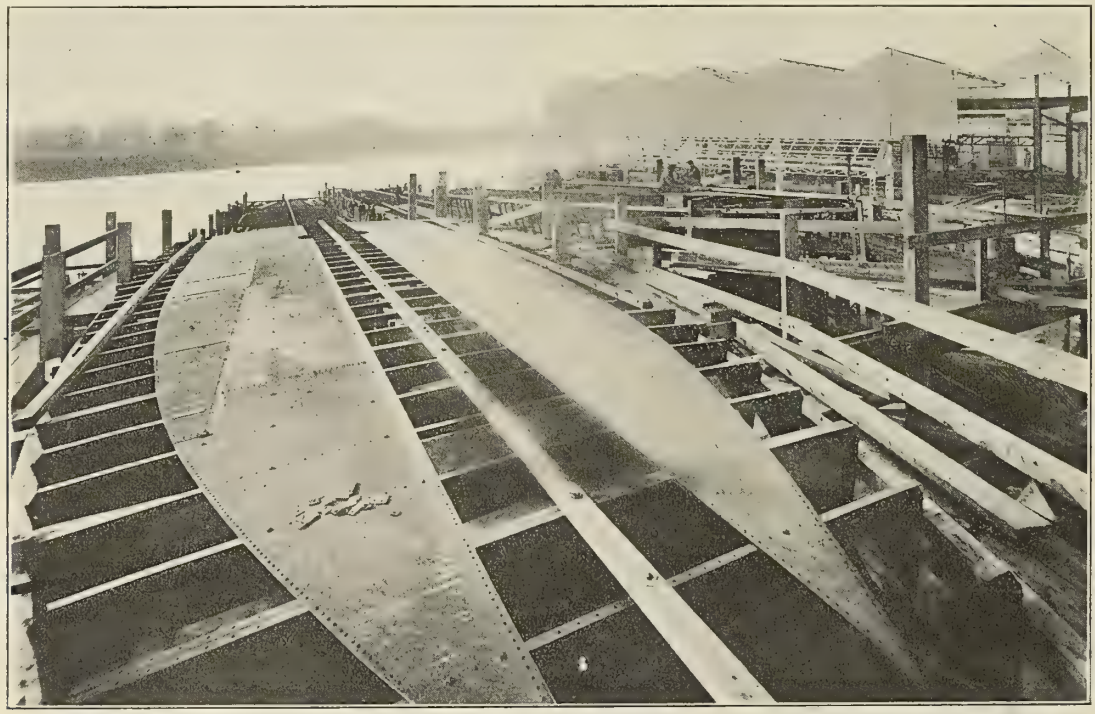
It took an afternoon and part of the night to complete this job, and the next morning the shaft was replaced in the engine and put to work. It has never shown the least indication of weakness so far, and is still, after eighteen months, apparently as good as ever. The new shaft, ordered as a hurry job, was received in two months, but is still kept in reserve. The joint between the two pieces of shaft was fortunately an inch or so inside of the pillow block, and is now undistinguishable from the rest of the shaft. The work of the engine, of course, always tends to screw the pieces tighter together; but it seems a little surprising that the threads do not strip off and let the two pieces separate. Probably the friction between the outer parts of the shaft takes up most of the torsional strain. The 4-inch stub would not last a minute by itself.—*Scientific American.*

The New Yarrow Yard at Scotstoun, Glasgow.

The new premises, which are situated at Scotstoun, about 5 miles from Glasgow, cover an area of about 12 acres, and have a river frontage of 784 feet. The yard is on the north side of the Clyde, and is adjacent to Scotstoun West station on the Lanarkshire & Dumbartonshire Railway.

The class of work which the firm will carry on in Glasgow will be similar to that which has hitherto been carried on in London; that is, the construction of torpedo boat destroyers and torpedo boats and shallow draft steamers of all types. The firm has lately been building some high-speed motor boats, driven by internal combustion engines, which have proved highly satisfactory. The first order with which the firm started at Scotstoun was for ten torpedo boat destroyers for the Brazilian government, which are now in course of construction. One has just been launched.

In deciding as to the laying out of the yard, good supervision and easy communication between the different departments were points to which particular attention was given.

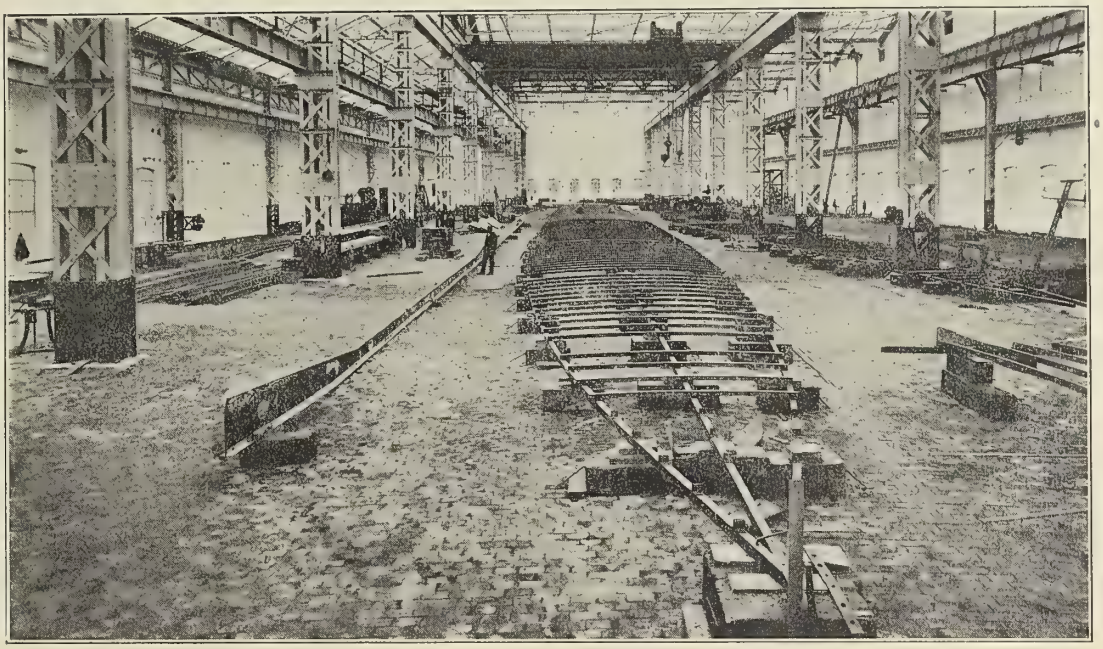


BRAZILIAN DESTROYERS UNDER CONSTRUCTION: THE COVERED WET BASIN IN RIGHT BACKGROUND.

The general offices are situated in the center of the northern boundary, facing South street, the engineers' shops being on one side and the boiler shops on the other, and the managers of these departments being within easy distance of the general offices. The west side of the yard is devoted to the buildings connected with the engineering side of the business, and consist of machine shops, general stores, tool stores, power station, smiths' shop and pattern shop. On the east side of the yard are placed those buildings which are connected with the shipbuilding and boiler-making departments, consisting of boiler shops, galvanizing shop and platers' shed.

The launching slips occupy about 360 feet length of the whole frontage, and are inclined to the edge of the river at an angle of about 60 degrees.

To the westward of the launching slips a wet basin has been constructed. The width of this basin is 86 feet at the cope level, and the length is about 330 feet. The basin is set at an angle to the river, to facilitate getting into the basin, and also to avoid the silting up of same. The basin has been



LAYING OUT THE DECK OF A BRAZILIAN DESTROYER IN THE BOILER SHOP.
(Copyright, McClure, McDonald & Co.)

dredged out to a depth of about 14 feet at low water, so that the ships will never ground.

The engineers' shops are 210 feet long, and consist of three bays, 65, 50 and 35 feet wide. In the widest bay there is a 50-ton electric traveler on upper rails, the height from the rail face to the floor level being 40 feet, and on lower rails a 5-ton traveler. The other bays will also be equipped with electric travelers. These shops have wood block flooring.

The boiler shops are 300 feet long, and consist also of three bays, 65, 50 and 35 feet wide, the spans being similar to the engineers' shops, but arranged in different order. The wide bay has a 50-ton electric traveler, and another of 10 tons capacity. The other two bays are also equipped with electric travelers. To serve the hydraulic riveter a 10-ton electric jib crane has been fitted up. These shops have wood block flooring. The galvanizing shop forms an annex to the boiler shops.

The space between the boiler shops and the platers' shed is equipped with a 7-ton electric traveler of 85-foot span and about 330 feet in run, and it is intended that the area commanded by this traveler will be used for building boats which have to be sent abroad in pieces.

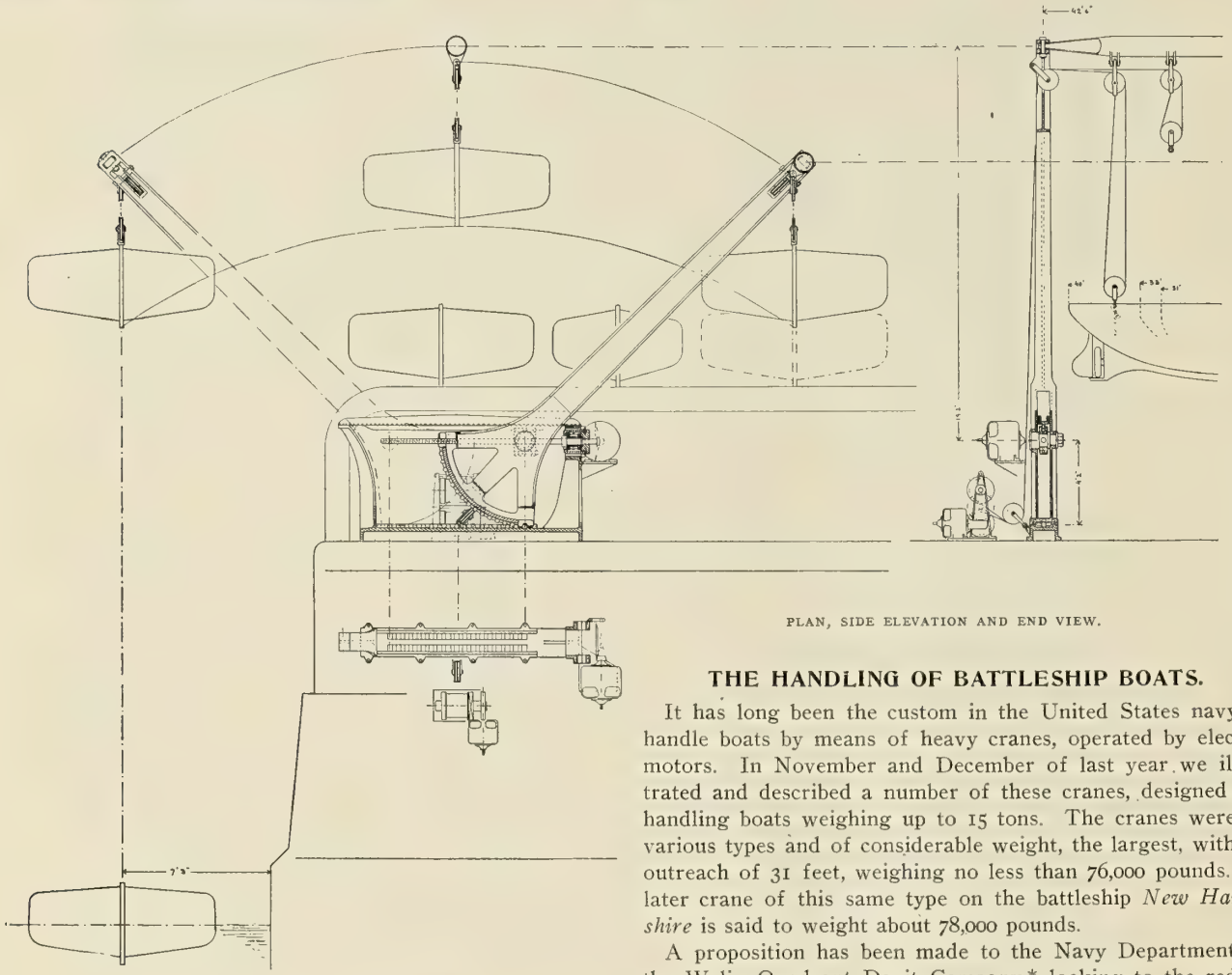
The platers' shed, 180 feet long by 90 feet wide, occupies a position near the head of the launching slips, and convenient for the punching, drilling and bending of plates. Motor-driven tools are also placed in the yard at the head of the launching slips.

The wet basin is roofed over, and the building equipped with a 50-ton electric traveler of 93-foot span, commanding the whole area of the basin. After launching the boats they will be taken into the wet basin to receive their machinery and to complete the fitting out.

The pattern makers' and joiners' shop is 270 feet long by 45 feet wide. In this shop the machinery is arranged about the middle of the lower floor. The joiners occupy one end of the building and the pattern makers the other end, and the

WATER FRONT OF THE YARROW YARD NEAR GLASGOW, SHOWING BRAZILIAN DESTROYERS BUILDING.

machinery will be common to both. One feature of this shop is the arrangement for driving the machinery. A pit is formed underneath the floor, and the machinery is driven by a motor placed in the pit. The motor will drive onto various lines of shafting, and belts from these carried direct to the machines, so that the belts will not in any way interfere with the working of the machines. The upper floor of this building will be used as a laying-off loft.



ARRANGEMENT OF DAVITS FOR BATTLESHIP.

It is intended to equip the smithy with four steam hammers, the largest being 40-cwt. size. In this building ample provision has been made for ventilation to carry off the fumes and smoke.

The works are driven by electric power; current being supplied by the Clyde Valley Power Company. Alternating current is supplied at 400 volts, 25 cycles per second. All motors ordered for new machines, etc., are alternating current, and it was decided to bring all the existing plant from London, this including about eighty direct-current motors. In order to supply current for these a motor generator is installed, supplying direct current at 210 volts. The general lighting throughout the yard is by electricity, and it was decided to place a gas jet at each machine in the engineers' and boiler shop.

One boiler is installed, which will supply steam for the steam hammers and also low-pressure steam for the heating of the shops; otherwise all the power is electric.

The railway system in the yard is such that easy communication is given with the Caledonian main line, and also easy communication between the various shops and from the shops to the wet basin, the traveler at the wet basin being able to pick up from the railway line, which may bring machinery out from any of the shops.

The steel work has been erected by Sir William Arrol & Company. The weight of the steel work in the engineers' shop is about 725 tons, and in the boiler shop nearly 800 tons. All the shops, with the exception of the pattern shop, are constructed of steel filled in with brickwork, principally 9 inches thick.

PLAN, SIDE ELEVATION AND END VIEW.

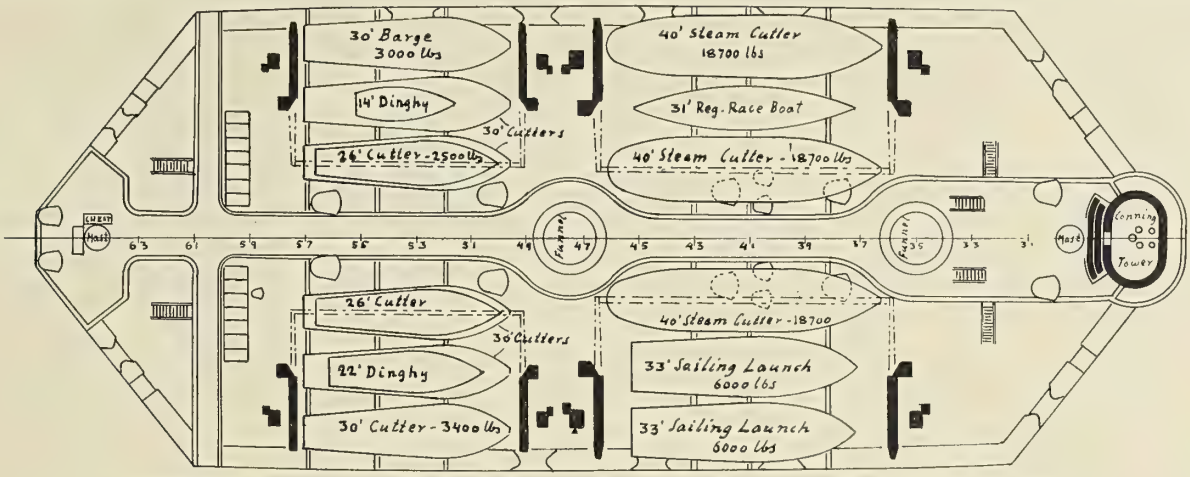
THE HANDLING OF BATTLESHIP BOATS.

It has long been the custom in the United States navy to handle boats by means of heavy cranes, operated by electric motors. In November and December of last year we illustrated and described a number of these cranes, designed for handling boats weighing up to 15 tons. The cranes were of various types and of considerable weight, the largest, with an outreach of 31 feet, weighing no less than 76,000 pounds. A later crane of this same type on the battleship *New Hampshire* is said to weight about 78,000 pounds.

A proposition has been made to the Navy Department by the Welin Quadrant Davit Company,* looking to the reduction in the weight of this sort of top hamper by the substitution of four pairs of double quadrant davits on a battleship for four of the previous cranes. The davits proposed are in two groups, heavy and light; the two heavy pairs being designed for the handling of the group of longer and heavier boats, such as the steam launches, etc.; while the two pairs of smaller davits are for the shorter and lighter boats. This grouping of the boats according to size and weight is for the purpose of utilizing to the best advantage the davits proposed.

The lifting capacity of the heavier davits would be 20,000 pounds, with the quadrant frames spaced 42 feet 6 inches apart; the lifting capacity of the smaller davits would be 4,000 pounds, with the quadrant frames spaced 32 feet apart. The total weight of each pair of the larger davits, with all apparatus, is approximately 24,000 pounds; while that of the smaller davits is 9,000 pounds. The total weight of the four sets complete is thus 66,000 pounds. This is seen to be much less than the weight of a single one of the very large cranes now employed for this purpose; and it is estimated that a total saving of about 100 tons would be effected in the top weights of a large battleship by the substitution here outlined.

* No. 17 Battery place, New York, and 5 Lloyd's avenue, London, E. C.

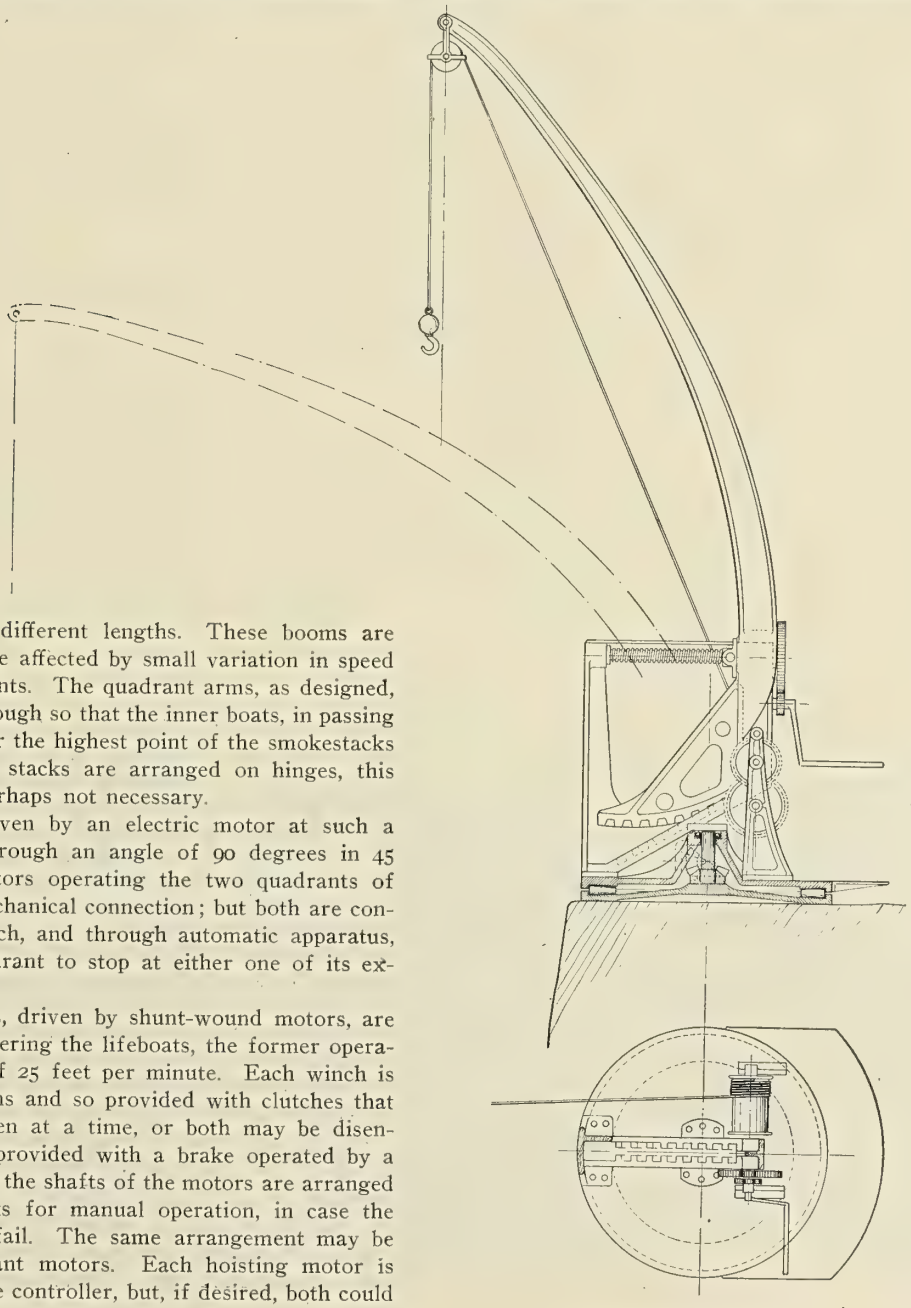


BRIDGE DECK OF THE BATTLESHIP KEARSARGE, SHOWING PROPOSED ARRANGEMENT OF WELIN QUADRANT DAVITS.

The two davits in each pair are joined at their upper ends by a steel boom, to which are secured tackles suitably arranged for handling boats of different lengths. These booms are arranged so as not to be affected by small variation in speed between the two quadrants. The quadrant arms, as designed, have been made long enough so that the inner boats, in passing over the outer, will clear the highest point of the smokestacks of a launch. As these stacks are arranged on hinges, this extreme clearance is perhaps not necessary.

Each quadrant is driven by an electric motor at such a speed that it moves through an angle of 90 degrees in 45 seconds. The two motors operating the two quadrants of each pair are not in mechanical connection; but both are controlled by a single switch, and through automatic apparatus, which causes each quadrant to stop at either one of its extreme positions.

Two hoisting winches, driven by shunt-wound motors, are used for lifting and lowering the lifeboats, the former operation being at a speed of 25 feet per minute. Each winch is equipped with two drums and so provided with clutches that one drum may be driven at a time, or both may be disengaged. Each drum is provided with a brake operated by a foot lever. The ends of the shafts of the motors are arranged for the fitting of cranks for manual operation, in case the electric supply should fail. The same arrangement may be installed on the quadrant motors. Each hoisting motor is provided with a separate controller, but, if desired, both could be controlled by a single switch, and through automatic starting apparatus, while the small changes in relative speed which might be necessary could be effected by means of a rheostat,



PIVOTED DIFFERENTIAL-TYPE DAVIT.

arranged to change the strength of the field of one of the motors, so as to either increase or decrease the speed of that particular motor. All of the motors would be designed to run without sparking, and, by reason of the intermittent and occasional character of their service, they would also operate without heating.

The drawing, showing the general arrangement of the quadrants to be operated through 90 degrees, makes provision for placing three boats side by side, and handling them all from the same set of apparatus. As figured out for one of the smaller battleships, this particular outfit gives an outreach at the waterline of 7 feet 3 inches from the side of the ship. The radius of the quadrant running in the rack is 4 feet 2 inches, while the radius of the long arm of the davit is 19 feet 2 inches. The davit arm is made of either cast or structural steel, while the framework is of cast steel.

The arrangements of these davits on the boat deck of a battleship of the *Kearsarge* type is shown in another drawing, where the space taken up by the framework and motors is shown in black, the extreme inward position of the davits being given by dotted lines. This arrangement is for the handling of sixteen boats, varying from a 14-foot dinghy to three 40-foot steam cutters weighing 18,700 pounds each. These latter are not up to the limit of the outfit as designed, but they represent about the heaviest type of boats used for this purpose.

Alternative proposals have been made, looking to the use of swinging davits with differential gear so arranged that at maximum outreach the power arm is also at a maximum. This is provided for by placing the rack at an angle, and so adjusting the curvature of the quadrant as to fit that rack at all positions.† These swinging davits would be pivoted and run upon a combination of roller and ball bearings, and would be operated to a certain extent in the same manner as the present cranes. They would, however, have the advantage possessed by the other davits of this type in being run out and in by the usual screw, and with considerable celerity. They would have the further advantage of being able to pick up a boat at any point within their radius, by virtue of the fact that the position of the upper sheave can be adjusted by a combination motion between the pivot and the traversing thread. In this case, of course, only a single davit would be used, in place of the pair provided for in the other proposition.

† See also page 61, International Marine Engineering, February, 1908.

Head-on Collision in Kaiser Wilhelm Canal.

The illustrations show the effect of a head-on collision which happened on June 16 in the Kaiser Wilhelm canal. Both steamers were going at low speed, and when they tried to clear each other, the steamer *Stadt Schleswig* did not obey the rudder. The pilot ordered full speed ahead in order to get steerage way, but it was too late to avoid collision. The *Schleswig* struck the steamer *Skelleftea* on the starboard bow, and while she lost her anchors (the broken shaft can be seen in the hawse pipe) and bent her bow, she also inflicted severe injuries to the *Skelleftea.*

Russian Armored Cruiser Amiral Makaroff.

BY JOSEPH G. PELTIER.

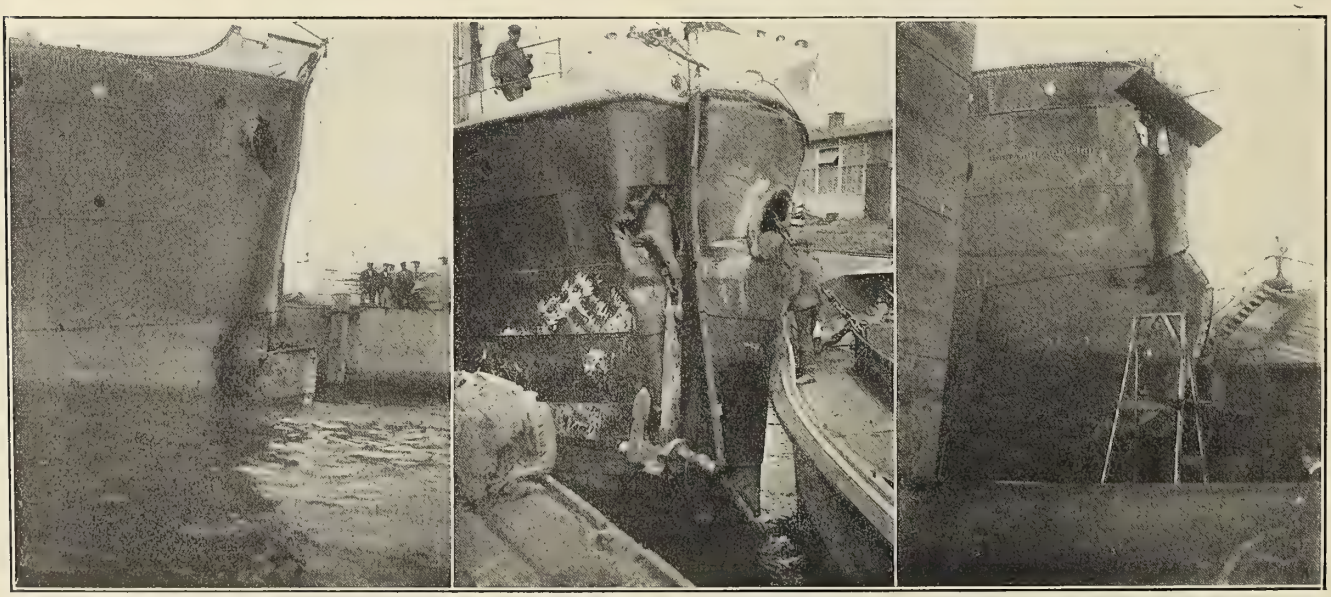
This cruiser is the only big ship built in France in 1907 for foreign account. She is the first of three new armored cruisers for the Russian navy; the two other boats being in course of building in the national dockyards in the Baltic. They are virtual reproductions of the *Bayan,* now the *Aso,* of the Japanese navy.

This cruiser has the following particulars:

	Meters.	Ft.	Ins.
Length between perpendiculars	135	443	..
Breadth at the waterline	17.50	57	5
Breadth at the height of the upper deck	17.56	57	8
Depth from main deck	11.60	38	1
Mean draft	6.51	21	5
Displacement in tons			7,877
Indicated horsepower, designed			16,500
Speed, designed, knots			21

HULL AND GENERAL PROTECTION.

The hull is of steel throughout, and fitted with bilge keels and docking keels. It is protected by an armor belt of Krupp special steel. The heavy strake of this armor is worked from stem to stern; the second strake above this is worked from stem only to the after casemates. The heavy strake has a total height of 1.8 meters (5 feet 11 inches), of which only 60 centimeters (2 feet) are above the waterline; this strake is 175 millimeters (6.9 inches) in thickness amidships and only 100 millimeters (3.9 inches) at the stem and stern; the second strake is worked up to the main deck; its thickness is of 100



STADT SCHLESWIG. SKELLEFTEA. SKELLEFTEA.

THE RUSSIAN ARMORED CRUISER AMIRAL MAKAROFF ON TRIAL TRIP.

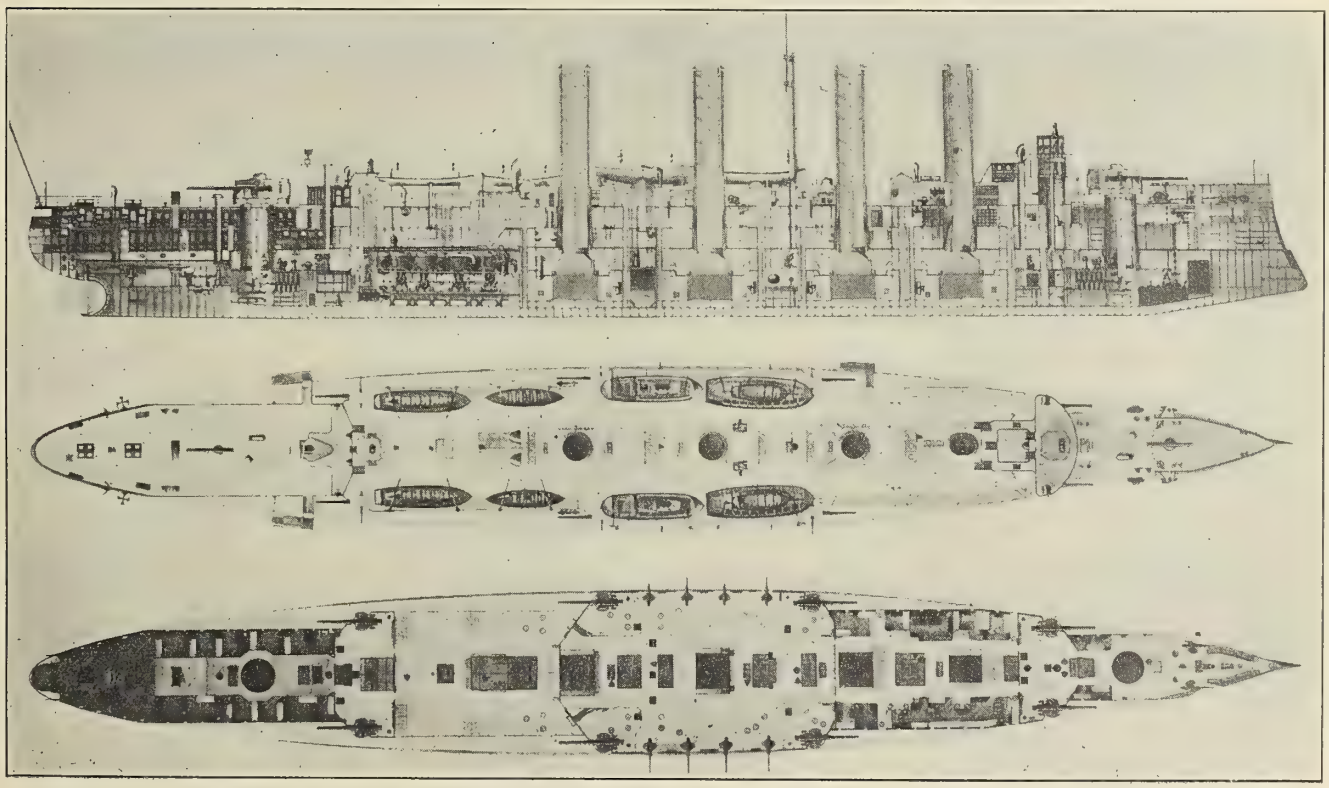
millimeters (3.9 inches) amidships and 80 millimeters (3.2 inches) at the ends. There is a protective deck, worked at the height of the upper edge of the main strake; this deck is protected with chrome-nickel plates supplied by Krupp. These plates are 50 millimeters (2 inches) thick on the slope and 30 millimeters (1.2 inches) on the flat.

The total weight of the armor belt, turrets and casemates, all protected, is equal to 23 percent of the displacement of the cruiser, or 1,810 tons. The hull is protected by a cofferdam running from end to end and behind the belt side armor. There are two conning towers, one ahead, one aft. The forward one is 136 millimeters (5.4 inches); the other one is thinner. Both are of Krupp special steel.

ARMAMENT.

The battery is composed of two 8-inch breech loading rifles; eight 6-inch rapid fire guns; twenty 3-inch and 3-pounder rapid fire guns, and four Maxim machine guns. The 8-inch guns are located in two axial turrets, one forward, one aft. They are protected by 150-millimeter (5.9 inches) Krupp steel on both turret and barbette. The 6-inch guns are located four on each side, in four casemates. At the center there is a special citadel, which also contains four 3-inch guns on each side; therefore, these small guns are well protected. The casemates and this citadel are protected by an outside plating of .100 millimeters (3.9 inches), worked up to the weather deck. There are also two submerged torpedo tubes for 450-millimeter (18-inch) torpedoes.

The fire will consist of, forward or aft, one 8-inch, four 6-inch; and the broadside fire of two 8-inch guns, four 6-inch guns and ten 3-inch guns. These guns have the following caliber: 8 inches, 45 calibers; 6 inches, 45 calibers; 3 inches, 52 calibers. The 8-inch guns are able to deliver three shots per minute. According to the lessons of the last war and the destruction of the French battleship *Iena,* the shell and powder rooms have been built with all possible care; there are air



INBOARD PROFILE, WEATHER DECK AND GUN DECK OF THE ARMORED CRUISER AMIRAL MAKAROFF.

bulkheads in the parts adjacent to boiler, engine or dynamo rooms. All turrets, shell hoists, pumps, ventilators, steering gear, etc., are electrically driven. As far as possible wood has been prohibited in the fitting of this vessel; the main part of the furniture is made of metal. For the first time in France there has been used the Wikström composition as deck fitting instead of linoleum. This composition is fireproof, and seems at first sight to be of cement.

MACHINERY.

The cruiser is fitted with two main engines, located in two watertight compartments. They are of the triple expansion, four-cylinder type, and drive each a propeller. The steam is supplied to the main and auxiliary engines by twenty-six boilers of the Belleville type, fitted with economizers. These boilers are located in four watertight compartments, divided into eight boiler rooms.

The usual bunkers have a total capacity of 1,050 tons, which, according to the trial figures, give a radius of nearly 7,750 miles at the cruising speed of 14 knots. The contract figure was only 7,000 miles at this speed.

TRIALS.

Consumption Trial for Six Hours.

	Trial.	*Contract.*
Indicated horsepower	3,300	.....
Consumption per hour and indicated horsepower, kilogram	0.535	1

Full Power Trial for Three Hours.

Indicated horsepower	19,615	16,500
Speed, knots	22.55	21
Admiralty coefficient	231	222

At the cruising trials at 14 knots speed the mean consumption for twenty-four hours was only 0.839 kilogram. These figures show the good qualities of both hull and boilers and machinery.

The original *Bayan,* also built at La Seyne, was noted as an unusually successful vessel. On trial she exceeded her contract speed by 1 knot, making 22 knots with 17,400 horsepower (Admiralty coefficient, 239). The coal consumption was only 1.4 pounds per horsepower per hour. On full power, in service, she burned about 14 tons per hour.

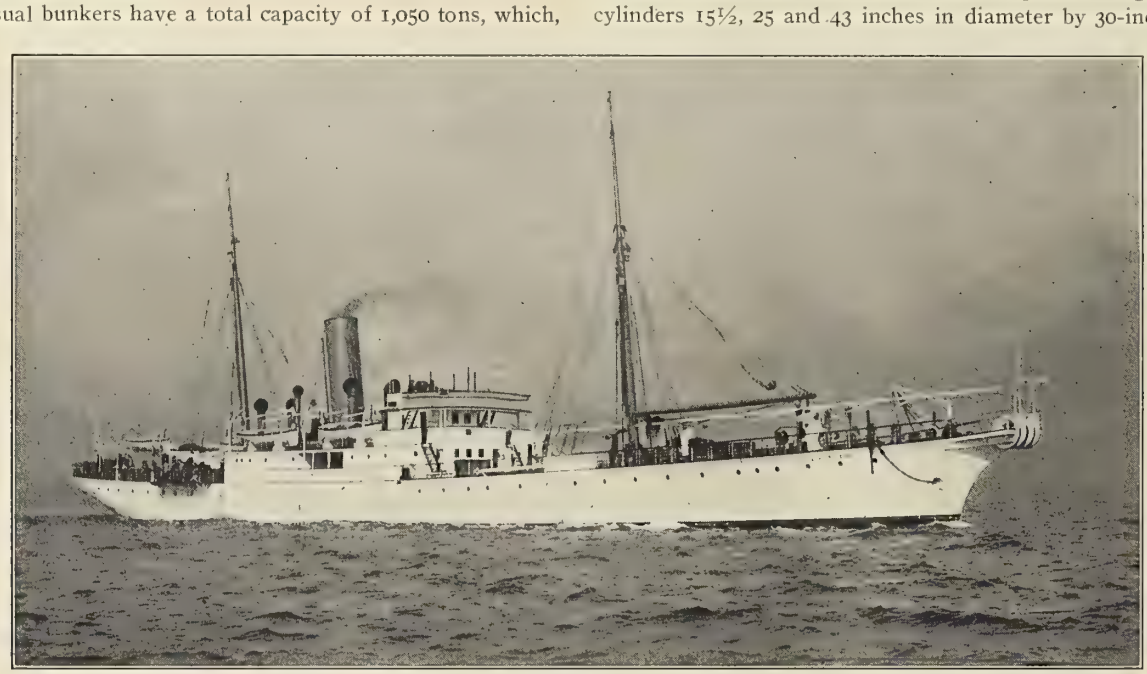
The Cable Steamer Guardian.

The *Guardian* is a twin-screw cable-repairing steamer, which has been specially built for the Central and South American Telegraph Company, of New York, to look after its extensive submarine cables in the South Pacific, where her headquarters will be at Callao.

Swan, Hunter & Wigham Richardson, Ltd., her builders, have had considerable experience in building cable-laying and cable-repairing steamers, and this, added to the owners' special knowledge of their requirements, have combined to make the *Guardian* one of the most complete and up-to-date steamers that has yet been built for cable-repairing work.

The dimensions of the ship are: Length over all, 293 feet; length between perpendiculars, 270 feet; breadth, 36 feet, and depth molded, 24¾ feet. At Lloyd's load draft she has a total deadweight capacity of over 2,400 tons.

She is fitted with twin-screw triple-expansion engines, with cylinders 15½, 25 and 43 inches in diameter by 30-inch stroke, and two large boilers fitted with Howden's forced draft. The hull, as well as the engines and boilers, have been built at the Neptune Works. When loaded under service conditions at a draft of 18 feet mean, the vessel easily maintained a speed of over 12½ knots on trial trip.



THE CABLE STEAMER GUARDIAN AT SEA.

One special feature is the unusually large bunker capacity, which is such as to enable the vessel to keep at sea for about forty-five days when cruising at a speed of 10 knots (10,800 nautical miles). She has large water ballast and fresh-water capacity.

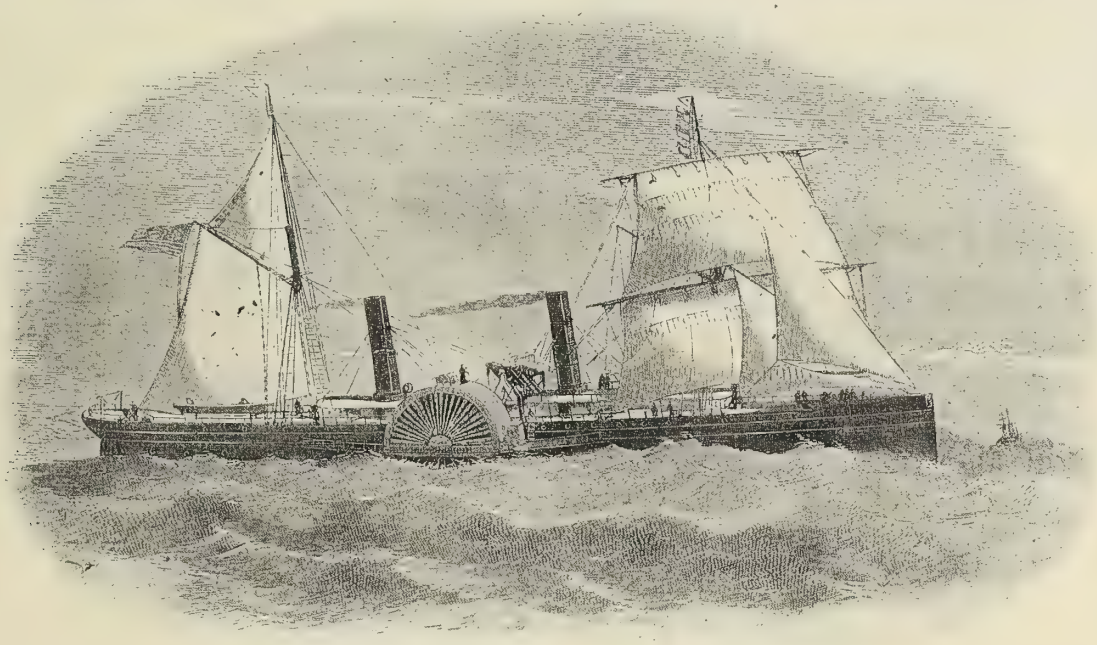
The vessel has four cable tanks with steel cones. The two largest of these cable tanks have each internal tanks, making six coiling tanks in all. The cable machinery for picking-up and paying-out is of Johnson & Phillips latest type. The testing room, which is at the fore part of the bridge, is a large, well lighted, comfortable room, fitted in polished mahogany, with a special battery room adjacent to it.

Comfortable, well-fitted accommodation for the captain, electricians, officers and engineers is provided on deck amidships, with saloon in polished oak, below the spar deck aft. The accommodation for the petty officers, cable hands, sailors and firemen is on the main deck.

The vessel has teak weather decks, and is provided with a steam capstan windlass, two steam winches, and steam and hand steering gear, also all necessary appliances for lifting and

stowing buoys, etc. She has six boats, including a motor launch. There is electric lighting throughout, with a searchlight placed on the captain's bridge. Refrigerating rooms are fitted for provisions, with machine of the CO_2 type, made by J. & E. Hall, London. Among other special fittings there is a Lucas deep-sea sounding machine.

the two paddle wheels were operated by separate engines, and that either could be run alone, or both at differing speeds. This must have been of great assistance in maneuvering. The vessel was used for some time in 1854 in connection with steamers on the Pacific in a service between New York and California by way of the Isthmus of Panama.



COMMODORE VANDERBILT'S STEAM YACHT NORTH STAR, BUILT IN 1852.

The North Star.

"This splendid specimen of American naval architecture has proved one of the most perfect-modeled steamers, for safety and speed, afloat. In her first trip she crossed the Atlantic in *ten days and eight hours.* Her owner, Commodore Vanderbilt, is a merchant prince and shipbuilder of New York. She is a paddle-box steamer, with two funnels, and registers 1,876 tons; she is capable of carrying 2,500 tons. She is 260 feet on the keel, 270 feet on the spar deck, 38 feet breadth of beam, 13 feet from floor timber to lower deck beams; 7 feet 8 inches between decks, 7 feet 6 inches between spar decks, making her whole depth 28 feet 6 inches. She has four boilers, which are 24 feet long, 10 feet diameter; the engines are upon the same principle as those used in our ordinary river steamboats. Handsome flights of stairs lead to the saloon, which is larger and more magnificent than the saloon of any ocean steamer afloat. Ranged around the saloon are beautifully furnished cabins, the doors and panels of solid bird's-eye maple and rosewood. Mirrors extending from the ceiling to the floor are fixed in the cabins. The walls are imitative marble and malachite, formed of a conglomerate of marble stone and glass—a recent American invention. It is fixed on wood peculiarly seasoned, and bears an exquisite polish. The *North Star* cost some $500,000, and her weekly expenses are about $1,700, exclusive of fuel. Everything on board is American. Surprise has been expressed at the small quantity of fuel consumed on board the *North Star,* when her speed is considered. In her passage across the Atlantic she consumed only fifty tons of coal a day, while the consumption ordinarily in such steamers is from seventy-five to one hundred tons daily. She has been enabled to traverse the ocean at so little expense by her being driven by what is called a beam engine—an American invention, which has never before been used in a steamer to cross the Atlantic."—*Gleason's Pictorial Dollar Weekly,* 1852.

Editor's Note.—Examination of the illustration shows that

The illustration and information were furnished us by William McAllister, City Island, N. Y., who, as a youth, was employed in the construction of the yacht. She was built by J. Simondson, at foot Eighteenth street, East River, New York; and engined by the Allaire Iron Works, New York.

Two huge battleships were launched in British shipyards Sept. 10. One was the *St. Vincent,* the largest and heaviest of British warships, launched from the government yard at Portsmouth. Her dimensions are as follows: Length between perpendiculars, 500 feet; beam, 84 feet; draft, 27 feet; displacement, 19,250 tons. The engines will be of 24,500 horsepower, and a speed of 21 knots is expected. The ship will be armed with ten 12-inch guns and a secondary battery of twenty 4-inch guns. The other vessel was the Brazilian battleship *Minas Geraes,* launched from the yards of Sir W. G. Armstrong & Whitworth, at Elswick, on the Tyne, a bigger and more powerful ship than the *St. Vincent.* She has a displacement of 20,000 tons, and is 530 feet in length, though she draws 25 feet only instead of 27. In armament she is superior to the *St. Vincent,* as she has twelve instead of ten 12-inch guns, and can bring all of them to bear on either broadside,* while the *St. Vincent* can bring only eight to bear. The secondary armament consists of twenty-two 4.7-inch guns. She is the first of three ships of this type. The *St. Vincent* is also the first of three, being a development of the *Dreadnought.* The main difference between the two ships, aside from the fact that the *St. Vincent* has Parsons turbines and the *Minas Geraes* reciprocating engines, lies in the arrangement of battery. The Brazilian has one extra turret (two 12-inch guns) forward, so mounted as to fire over its mate. The two waist turrets are moved further aft; and the turret next the last is raised to fire over the after turret.

*There seems to be a little doubt on this point, but it is certain that ten, at least, can be so concentrated.

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Shipbuilding.

The whole situation is very discouraging. Lloyd's report, for the quarter ended June 30, 1908 (figures for the September quarter are not yet at hand), shows a total gross tonnage under construction in Great Britain of only 799,178, as compared with 1,250,318 gross tons in hand a year ago. This represents a reduction of 451,140 tons, or more than 36 percent. It is the lowest total recorded by Lloyds since 1896.

Various causes are given for this state of affairs, the shipbuilding strike having apparently something to do with it, but it seems to be more generally conceded that the basic cause lies in over-production. The calendar years 1906 and 1907 were the two largest in the history of British shipbuilding. The former was a record by long odds, and the latter fell comparatively little short of it. It would appear, on the face of the returns, that the enormous output of these two years has not by any means been absorbed by the requirements of the business. When to this over-production we add the fact of a very sharp decline in general business, beginning about a year ago and not yet entirely over, resulting in a reduction in commercial transactions and, consequently, in the movement of freight by water as well as by rail, it is not at all surprising that dozens of ships are tied up idle in British and continental ports, and that the new work in hand has fallen off so decidedly.

In the United States the depression is probably much more marked than in Britain. The report for the month of August of the Bureau of Navigation in Washington showed the construction in that month in the United States of *no less than five steel steamers, with an aggregate of* 514 *gross tons.* Wooden vessels propelled by steam and sail brought these figures up to 125 and 4,583, respectively, but it is only the steel steamer that counts to the fullest extent in a return of this sort. It would thus appear that the shipbuilding industry of the United States is fast approaching the vanishing point. In addition to the general industrial depression, other contributory causes are found for American shipbuilding depression in the fact that, with the high wages prevailing in American shipyards, competition against British, and particularly Scotch, shipbuilders is totally out of the question These wages are slightly lower, perhaps, than those prevailing in similar lines of work in other industries in the United States, so that a further lowering of this item would cause labor to shun the shipyard district entirely, and the vanishing point would then be right at hand.

For some years an agitation has been carried on in the American Congress looking to the institution of some artificial means of equalizing matters as between the cost of constructing and operating ships in the United States and under American laws and the cost of constructing and operating ships under European conditions. Preferential tariffs, favoring the American-built and operated vessel, have been advocated in some quarters; and violently opposed in others. A direct bounty, or subsidy, to American-built and operated ships on certain specified routes and fulfilling certain conditions as to speed, frequency of voyages and the carrying of cadets, has four times been brought directly before Congress; and each successive time it has been defeated by a margin smaller than the preceding. It is to be under consideration again this winter, and those are not wanting who believe thoroughly that it will be put into effect.

Some critics of this scheme advocate "free ships" for America, meaning the admission to American registry of any ship whatsoever, wherever she may have been built. This would scarcely add to the business of American shipbuilders, and it should be noted here that the problem as a whole is two-headed—the

problem of the shipbuilder and the problem of the operator, and neither one is to be solved at the expense of the other. Free ships might help the latter, but would be ruinous to the former, if a business already well-nigh killed can undergo further ruination.

The Fighting Values of Warships.

A German authority has contributed to a recent number of *Schiffbau* a study of the values of the principal warships of the world, based upon an arbitrary formula which he has devised, and which takes account of the various offensive and defensive features of each individual ship. Some of the results obtained are more or less startling, for he gives the *Michigan* of the American navy a value of 85, as against a value of 80 for the *Satsuma,* 77.1 for the *Dreadnought* and sisters, 70.2 for the *Nassau,* 66.7 for the *Lord Nelson* and 65 for the *Danton.* After giving in detail the figures for twelve battleships and ten armored cruisers, he proceeds to take up the types of ships in the various navies, and to give totals for battleships and large cruisers, and for the entire fleets. In these latter figures it is interesting to note that he has given the American *Delaware* class a value of 100; the *Invincible,* 77; the new 20,800-ton Japanese ships, 90; and the new Russian designs of 22,000 tons a value of 90.

Without going into the detail in which the figures are given, we may recapitulate his final results as follows:

Navy.	Ships.	Displacement.		Fighting Value.		
		Total.	Average.	Total.	Average.	Per Million Tons
Great Britain.	144	1,736,270	12,057	2,057	14.3	1,185
United States.	46	593,190	12,895	1,179	25.63	1,988
France.....	69	728,900	10,564	1,087	15.75	1,491
Germany.....	43	507,890	11,811	884	20.55	1,740
Japan.....	31	399,710	12,894	788	25.41	1,971
Russia.....	29	334,440	11,532	538	18.5	1,609
Italy.....	26	276,420	10,632	185	7.12	670
Austria.....	14	104,420	7,459	100	7.15	957

It is seen that the United States is given the largest average fighting value, with Japan a close second and Germany third. Even Russia and France are placed ahead of Great Britain. This is due largely to the inclusion in the British figures of such old vessels as the *Collingwood, Colossus,* etc., which have already been sold for old iron. The British figure is also brought low by the inclusion of several cruisers of the *Arrogant* and similar classes, while the more powerful cruiser *Olympia* is omitted from the American figures, with corresponding benefit to the American average. It is interesting to note that the *Arrogant* class is given a credit of only 0.2 point. As there are included twenty-nine British cruisers with less than one point credit each, this readily explains the low British average. The high Russian average is due to the inclusion of two battleships of which the keels have not yet been laid, while only four British *Dreadnought* type battleships are shown, the three of the *St. Vincent* class, one of which is already in the water, being entirely ignored, as is also the American *New Hampshire,* now some time in service.

As illustrating the tremendous advance in the power of naval ships during the last ten or twelve years, it may be noted that the famous *Oregon* of Spanish War fame is credited with 13.13, as compared with 100 for the *Delaware.*

The "two-power" standard is being maintained against all but a combination of France and the United States, which shows 2,266 points to 2,057 for Great Britain. The Anglo-Saxons have 3,236 points, against 1,625 for the old Franco-Russian entente; 1,169 for the "Dreibund"; and 2,794 for the five continental powers combined.

Warships under Construction.

A contemporary lists in each number the principal warships being built for the various naval powers. The lists given in the September number form interesting food for thought.

Germany is shown to have under construction nine battleships, three armored cruisers and six scouts, with an aggregate displacement of 226,400 tons. Great Britain is second, with ten battleships, one armored cruiser and two scouts under construction, the displacement being 215,800 tons. The third power is France, with six battleships and four armored cruisers, accounting for 163,582 tons. Italy stands fourth, with five battleships and five armored cruisers, amounting to 126,875 tons.

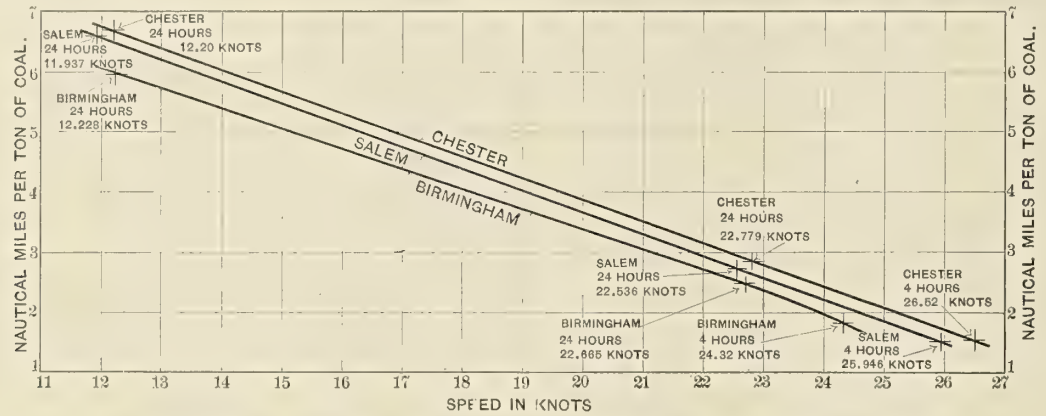
Of the powers with less than 100,000 tons under construction Japan is first, with five battleships and one scout, a total of 92,100 tons. Russia is next, with four battleships, two armored and one protected cruisers, accounting for 81,150 tons. The United States comes third, with four battleships aggregating 72,000 tons. Brazil has three battleships and two scouts, amounting to 64,750 tons; while Austria has three battleships and one scout aggregating 47,000 tons.

The nine powers are building no less than forty-nine battleships, fifteen armored and one protected cruisers and twelve scouts, with a total displacement of 1,089,657 tons. The British traditional two-power standard would appear to be in danger; for not only is Britain building less than France and Germany combined, but less than Germany alone. It may be stated in this connection that the British figures include all four of the *St. Vincent* class, one of which is in the 1908 program, as well as the fourth of the *Indomitable* type. Similarly the German figures include three battleships and one battle cruiser to be laid in 1908. The figures would, therefore, appear to be entirely contemporaneous.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States Navy:

	Tons.	Knots.		Aug. 1.	Sept. 1.
BATTLESHIPS.					
South Carolina..	16,000	18½	Wm. Cramp & Sons.....	55.	58.1
Michigan.....	16,000	18½	New York Shipbuilding Co.....	60.4	65.1
Delaware.....	20,000	21	Newport News S. B. & D. D. Co.	35.3	40.5
North Dakota...	20,000	21	Fore River Shipbuilding Co.. ..	45.7	50.1
TORPEDO BOAT DESTROYERS.					
Number 17.....	700	28	Wm. Cramp & Sons.....	38.7	49.3
Number 18.....	700	28	Wm. Cramp & Sons.....	35.7	46.7
Number 19.....	700	28	New York Shipbuilding Co.....	42.2	47.9
Number 20.....	700	28	Bath Iron Works.....	14.	20.1
Number 21.....	700	28	Bath Iron Works.....	14.	20.1
SUBMARINE TORPEDO BOATS.					
Number 13.....	—	—	Fore River Shipbuilding Co.....	51.9	55.7
Number 14.....	—	—	Fore River Shipbuilding Co.....	51.9	54.5
Number 15.....	—	—	Fore River Shipbuilding Co.....	50.9	54.1
Number 16.....	—	—	Fore River Shipbuilding Co.....	51.1	53.8
Number 17.....	—	—	Fore River Shipbuilding Co.....	42.4	48.2
Number 18.....	—	—	Fore River Shipbuilding Co.....	41.8	47.9
Number 19.....	—	—	Fore River Shipbuilding Co.....	41.3	46.8



CURVES FOR SCOUT CRUISERS, SHOWING NAUTICAL MILES PER TON OF COAL AT VARIOUS SPEEDS.

Steaming Radius of Scout Cruisers.

Editor International Marine Engineering:

Your assumption on page 389 of the September number that the power (and, consequently, coal consumption per hour) at high speeds of the *Salem, Chester* and *Birmingham* varies as the cube of the speed is scarcely correct, because at these high speeds the index to the power would be considerably greater than the cube. The better way would be to plot the curve, and take the nautical miles run per ton of coal at corresponding speeds of each ship. With this idea in view, a curve has been plotted, with speed in knots as abscissæ, and nautical miles run per ton of coal as ordinates. This curve shows for each ship a definite spot at about twelve knots, another at about 22½ knots, and a third at full speed, varying from 24.32 knots in the case of the *Birmingham* to 26.52 in the case of the *Chester*.

If, now, we take from this curve the nautical miles run per ton of coal for the three ships at any desired speed, the radius of action can readily be figured from the assumed bunker capacity. Taking these figures for the full speed of the *Birmingham* and of the *Salem*, we find the following results:

At 24.32 knots:	*Birmingham.*	*Chester.*	*Salem.*
Nautical miles per ton.....	1.822	2.28	2.1
Radius on 950 tons.....	1,730	2,165	1,996
At 25.946 knots:			
Nautical miles per ton.....	....	1.73	1.51
Radius on 950 tons.....	....	1,643	1,434

These would seem to show that at 24.32 knots the *Chester* has a radius 25 percent better than the *Birmingham*, and 11½ percent better than the *Salem*. At 25.946 knots the *Chester's* advantage over the *Salem* appears to be 14½ percent.

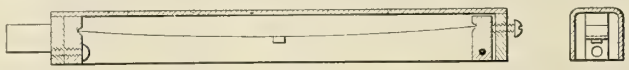
Regarding the difference in displacement, the contract stated that the ships were to be run at not over 3,750 tons; but any saving in machinery weights was to be allowed to benefit the contractor. The *Chester* turbine weights aggregate 155 tons, as compared with 204 tons in the *Salem*. The heaviest rotor in the *Chester* weighs 10.2 tons, as compared with 72 tons in the Salem. With regard to this last item, however, it should be noted that the *Salem* has only two rotors, where the *Chester* has six. Parsons.

ENGINEERING SPECIALTIES.

A Heat-Regulating Device.

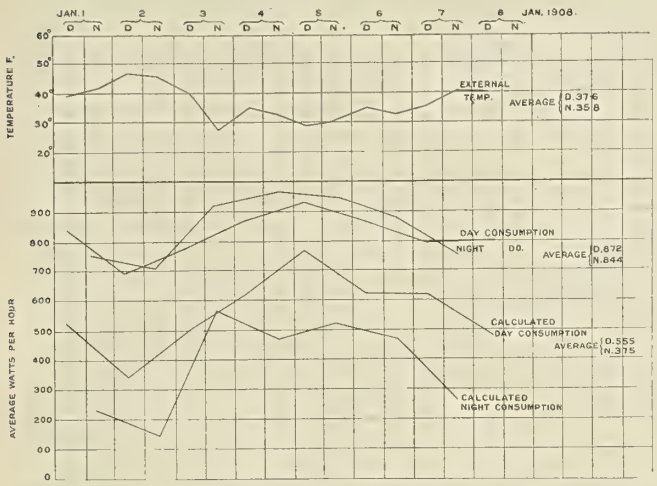
A new electric thermostat has just been placed on the market by the Geissinger Regulator Company, 203 Greenwich street, New York, which is entirely different from any of the heat-controlling devices at present in use, and is said to possess some very marked advantages over all of them; the greatest of these being that it is absolutely unaffected by vibration. It will stand being knocked about or hammered without being put out of commission, and will operate equally well on the counter of a fast steamer or on a railway train.

Dr. Geissinger hit upon an extremely simple, clever and effective method based on the principle that, in a very flat arc, a shortening of the chord causes a correspondingly



greatly increased lifting of the arc at the center. In accordance with this principle, the thermal element consists of two metals having a considerable difference of expansibility; say, zinc and steel, but other metals may be used. We show a diagrammatic view of the thermal element in elevation and section, as used in the regulation of heat in steamship staterooms. The zinc in this case is the rigid portion of the element, so to speak, and is of a U section; the steel or flexible portion being in the form of a light steel spring carried between V-shaped steel holders, one of which is made adjustable. The contact point is of platinum, and placed at the center of the spring.

It will be seen that an almost infinitesimal reduction in the length between the V-shaped holders, due to a fall in temperature, will cause a considerable upward or outward movement of the spring at the platinum contact point, causing it to come in contact with another point fixed on the frame of the instrument, so closing an electric circuit operating a specially designed switch, which, in its turn, closes the heater circuit. A peculiar feature of this arrangement of spring is that when the contact closes it does so with a definite pressure of about 4 ounces. This is sufficient to press out all dust or other

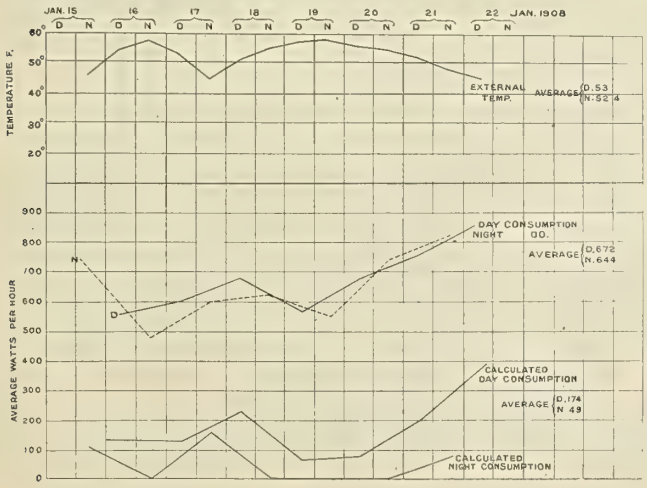


foreign matter, and, together with all absence of vibration, accounts in a large measure for the fact that after continual working for over two years the contact points show no signs of oxidization. It is hardly necessary to point out that, when the temperature increases, the reverse action takes place, the heater being thrown out of action.

So sensitive is the element, when unprotected by a casing, that the heat of the hand or of the breath is sufficient to break the heater circuit. If an incandescent lamp be substituted for the heater it is possible, by breathing on the thermostat, to produce the peculiar phenomenon of blowing out an electric lamp.

Many uses to which this thermostat can be applied will at once suggest themselves, such as, in addition to controlling the temperature of staterooms, the controlling of temperature in refrigeration tanks and holds in meat-carrying steamers, the maintaining of a definite temperature in the shell rooms and magazines of battleships, by controlling the action of the refrigerating machinery used for cooling the same. In this case the electric portion of the instrument is entirely outside the magazine. The company is now perfecting the application of the instrument to the regulation of steam heat, which, when completed, will enormously increase its field of usefulness.

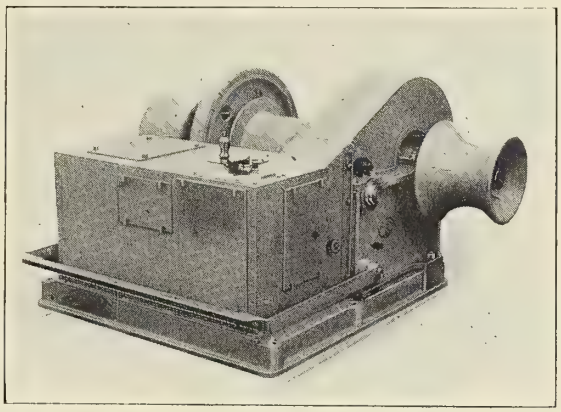
The thermostat, as designed for use in staterooms, is fitted with two thermal elements, either one of which may be set to a given temperature independently of the other. This arrangement enables one element to be set at whatever day temperature the occupant of the room requires; the other, to the desired night temperature. The placing of a three-point switch is all the occupant of the room requires to get day or night temperature, or no heat at all. This arrangement precludes the necessity of any tampering with the instrument by incompetent persons.



As an example of the saving to be effected by the use of the instrument in controlling the heating current in steamship staterooms electrically heated, the appended charts of observation taken on board the *Oceanic* will be of interest. It will be seen that with the regulation of the heat under the control of the passengers themselves, the amount of current used was nearly as great with a mean atmospheric temperature of 53° F. as when the mean temperature was 16 degrees lower. The lower curves on the charts show the amount of current that would have been required had every room been controlled by a Geissinger thermostat, the difference between the two voyages in this case being most apparent. The saving in current would have amounted to nearly 50 percent, based on maintaining a day temperature of 70° F. and a night temperature of 64° F. The saving in expense, taken for the seven months when heat is desirable, and based on one hundred heaters, would be $1,225 (£252).

An Electric Winch.

The winch illustrated is placed on the market by Chambers, Scott & Co., Motherwell, near Glasgow, and is said to be characterized by both speed and economy in handling loads. It is designed for cargo purposes, and is both more silent and efficient, as well as easier to work, than the ordinary steam winch. The arrangement in general resembles existing types of cargo winches, with a center drum and warping ends. The



details of parts and methods of working, however, are quite different.

A box sole plate carries all the parts, the gear being mounted on two standards, with the motor at the rear, and with provision made for fastening the whole to the deck. The main drum is provided with a clutch and powerful foot treadle brake, so that lowering can be effected very rapidly without current; the warping ends during such an operation remaining stationary. The gearing, motor control apparatus and cables are located in built-in steel covers, for protection from the weather. When used for warping, absolute control is assured by the operating gear and the drums, which are placed entirely clear of the body of the winch, are fitted with electric brakes, and are automatically held by the magnetic brake when the controller is in the "off" position.

An Improved Adjustable "S" Pipe Wrench.

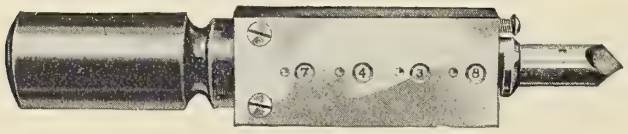
This wrench is a new product of the Billings & Spencer

Company, Hartford, Conn., and in general design it follows the lines of their regular adjustable "S" wrench; but it has a serrated jaw for use on pipe. Every part is a drop forging from steel, and the jaws are hardened. The sliding jaw is fitted in a double groove, which greatly adds to the strength of the tool. The patent thumb screw on the adjusting nurl securely locks the jaw at any desired opening.

The wrench is made in three sizes, 6, 8 and 10 inches. It is of careful workmanship throughout, and its design is such as to make it very useful in confined places, where an ordinary wrench would be inconvenient.

Another Revolution Counter.

An instrument placed on the market by Schuchardt & Schütte, 136 Liberty street, New York, will register from zero to 10,000 in either direction, and will then repeat. It can be easily set to zero from any number. The digits are lined



up in a row for direct reading, doing away with the often puzzling use of a pointer and dial. For adjusting, a pinion with small toothed wheel at the back of the counter is screwed into a hole marked *"R,"* or another marked *"L."* If set at *R* it must be used only for recording right-hand revolutions, and similarly for *L*. A number of arrangements are provided for arbitrarily setting the register at any desired figure or at zero, which could best be appreciated by trial.

TECHNICAL PUBLICATIONS.

Deutscher Schiffbau, 1908. Edited by Prof. Oswald Flamm, editor of *Schiffbau*. Size, 8 by 11½ inches. Pages, 230 + xx. Figures, 239. Berlin, S. W., 68: Carl Marfels Company. Price, 3 marks (paper covers).

This is a review, not only of German shipbuilding in 1908, but of the development of the industry throughout a long period of years. It is divided into thirteen chapters, covering, respectively, the development of the German fleet; the modern construction and the future of piston engines; the steam turbine in the propulsion of ships; the development and present position of marine boiler and engine construction in Germany; marine gas engines; technical education in ship construction; the relation of the German iron and steel industry to shipbuilding; shipyards; cranes in German shipbuilding; the German shipbuilding industry; general view of the principal laws and classification of merchant ships; electric outfits, and ships' equipments and fittings. Each of these chapters is by a separate author, himself a specialist along the line covered.

The illustrations consist of both half-tones and line cuts, the latter being apparently very good zincs. They are scattered with considerable profusion throughout most parts of the text, and include a great variety of subjects, from exterior views of ships and boats of various classes to sections of these vessels, propelling engines, steering gear, manufacturing plants, ships' auxiliaries and the thousand and one things that go to make up the structure and outfit of a modern merchant or war vessel. In the last chapter are found anchor chains, two illustrations of Welin quadrant davits, submarine signals, Clayton fire extinguishing apparatus, refrigerating outfits, etc. The work is splendidly gotten out, and gives a very good idea of the German shipbuilding industry in all its branches.

Marine Engineering: A Text-Book. By Engineer-Commander A. E. Tompkins, R. N. Size, 5⅞ by 8⅝ inches. Pages, 812. Figures, 403. London and New York, 1908: Macmillan & Company. Price, 15/– net and $4.50 net.

This is the third edition of the work, which has been entirely rewritten and largely expanded. There are many new illustrations and ten new chapters; the thirty-five present chapters being grouped into ten sections, covering, respectively, the introduction, which is so developed as to cover the syllabus used in the naval training establishments; marine boilers; combustion; the marine reciprocating engine; the condenser and feed-water systems; steam; propulsion; auxiliaries; care and management; and recent developments, including the steam turbine and the explosive engine.

Very little space is devoted to obsolescent types of boilers and machinery, but the thermodynamics of steam is more fully developed, so as to cover the requirements of the sea-going engineer. Every effort has been made to explain matters in as simple a manner as possible, without overlooking the practical application of mathematics as an essential to the design and economical working of marine machinery. The illustrations are mainly zinc drawings of the numerous and varied pieces of mechanism described, as well as diagrams and charts showing the expansion of steam, the operation of valve gear and the many features of marine engineering usually treated in such a book.

The main new features of interest are naturally the last two chapters, relating, respectively, to the marine steam turbine and the internal combustion engine. In the former case nearly the whole chapter is devoted to the Parsons turbine and its various applications on shipboard. Brief attention is given, however, to the Curtis and Rateau turbines, both of which are now being fitted to some extent on both warships and merchant ships. The discussion of the internal combustion engine includes some material on the use of producer gas, and a considerable amount of detail on carburetion and ignition of the engine. Many engines are illustrated in section, and brief mention is made of the system described some time ago in our pages of electric transmission in connection with the Diesel oil engine.

An appendix gives questions from examination papers covering the general scope of the text, and with occasional answers where these may readily be inserted. The work is very much greater in extent than its predecessor of the second edition, and appears to form a good working text on the general subject covered.

Amérique et Japon. By John Spartali. Pages, 318. Illustrations, 75. Size, 7½ by 11¼ inches. Paris, 1908: *Le Yacht*. Price, 8.50 francs; post free, 9.25 francs.

This work, which is given a brief preface by Vice-Admiral A. Bienaimé, was called forth largely by the cruise of the American squadron around the world, and by the friction previously existing between Japan and the United States. It is divided into three parts, the first of which deals with diplomatic, political and economic questions, and with a brief history of the Spanish-American and the Russo-Japanese wars. This part comprises ten chapters and about sixty pages.

The second part describes in some detail the warships of the two powers, and it is in this part that most of the illustrations are placed. More than two hundred pages are devoted to these warships, which are taken up in order, battleships, armored cruisers and other vessels being treated in considerable detail, with illustrations, consisting of both half-tones and line drawings, the latter giving the general distribution of battery and armor.

The third section, covering about thirty-five pages, deals with the personnel of the Japanese and American armies and navies. An attempt is made to show the inferiority of the American naval crews as compared with the Japanese; while,

of course, the army of the United States, by virtue of its small size, is likewise considered far inferior to that of the rival power.

The work, which is in French, is valuable mainly by reason of the naval data and comparisons which are included.

Hendricks' Commercial Register of the United States. Size, 7½ by 10 inches. Pages, 1,240. New York, 1908: Samuel E. Hendricks Company. Price, $10.00.

This is the seventeenth annual edition of a work dating from 1891, and contains upwards of 350,000 names and addresses, classified under about 33,000 trade headings. The index to the contents covers no less than 82 pages, and the general scope of the work is such as to make it extremely valuable as a buyer's reference and for mailing purposes. It is especially devoted to the interests of the architectural, mechanical, engineering, contracting, electrical, railroad, iron, steel, hardware, mining, mill, quarrying, exporting and kindred industries. It is so arranged as to make for easy reference, is fitted for cross reference and is corrected up to date.

The Proper Distribution of Expense Burden. By A. H. Church. Size, 5⅛ by 7⅝ inches. Pages, 116. New York and London, 1908: *The Engineering Magazine.* Price, $1.00 and 4/–.

This is a contribution to the much-vexed question of correct cost accounting, and represents a series of articles on the subject, which first appeared in *The Engineering Magazine.* The correct distribution of the expense burden is a very important and difficult problem, and mistakes in this distribution have led to very frequent disaster. The analysis conducted in this volume is simple but thorough, and such as to appeal to the common sense of the reader. Broad principles are laid down by which safe and reliable figures may be obtained for machine, piece and job costs. These principles will properly distribute all expenses of manufacture, marketing and management, so that the truth may be known as to the profit or loss of any line of product, and the cause of any change in manufacturing cost may be instantly detected.

The work is divided into six chapters, as follows:

Interlocking General Charges with Piece Costs; Distributing Expense to Individual Jobs; the Scientific Machine Rate and the Supplementary Rate; Classification and Dissection of Shop Charges; Mass Production and the New Machine Rate; Apportionment of Office and Selling Expense.

Internal Combustion Engines: Their Theory, Construction and Operation. By Rolla C. Carpenter, M. M. E., LL. D., and Herman Diederichs, M. E., Professors of Experimental Engineering, Sibley College, Cornell University. Size, 6 by 9¼ inches. Pages, 597. Figures, 373. New York, 1908: D. Van Nostrand & Company. Price, $5.00 net; London: Crosby, Lockwood & Son.

This is a very comprehensive work, divided into eighteen chapters and a complete index, of which the first five chapters relate to definitions and theoretical considerations. These are followed by chapters on combustion; gas engine fuels and gas producers; the fuel mixture; history of the gas engine; modern types of engines; auxiliaries; regulation; estimation of power; testing; performance of gas engines and producers; cost of installation and of operation. The book is largely compiled from different sources, and is in the main an outgrowth of a course of lectures on the internal combustion engine delivered to students of Sibley College during the past three years.

The illustrations are scattered through the text in great profusion, and include both half-tones and line cuts, depicting exterior and sectional views of different types of engines, producers and auxiliaries and charts showing the performance of engines under various conditions, as well as indicator cards and theoretical engine cycles, etc. The use of the calculus in developing the theory in the first few chapters indicates that the book is intended for the advanced reader, but the descriptions and computations in other parts of the work are sufficiently clear and simple for anyone interested in the subject.

The last chapter shows in brief, so far as information is available, the probable capital cost of an installation of gas engines, the cost of erection, operating expenses, etc. It is shown most strongly that the question of fuel cost is not always the item of greatest importance, a point which is often lost sight of in discussions regarding the comparative merits of various prime movers. It is realized that reliable information regarding some of the features of this financial problem is very scarce, owing largely to the comparative newness, so to speak, of the gas engine problem. It is also pointed out that many so-called comparisons between various prime movers, as between steam and gas, are often based upon hypothetical estimates that fit only the particular case under discussion, and any generalization of the results obtained from such discussions often leads to serious misconception and even misrepresentation.

QUERIES AND ANSWERS.

Questions concerning marine engineering will be answered by the Editor in this column. Each communication must bear the name and address of the writer.

Q. 417.—Please illustrate Kent's method of procuring cylinder diameters for a triple-expansion engine of 8,500 indicated horsepower at 120 revolutions per minute and a boiler pressure of 250 pounds per square inch. Let the stroke be 48 inches. W. B. B.

A.—The ordinary horsepower formula is

$$I.\,H.\,P. = \frac{P\,L\,A\,N}{33{,}000}$$

where P is the mean effective pressure referred to the low-pressure cylinder; L is the stroke in feet; A is the area of the low-pressure piston in square inches, and N is the number of strokes per minute. The mean effective pressure is given by the formula

$$p_m = p_1 \left(\frac{1 + hyp.\ log.\ r}{r} \right) - p_b,$$

where p_1 is the initial pressure of the steam in pounds absolute per square inch; p_b is the back pressure; r is the ratio of expansion.

Using the data given, and assuming that the drop in pressure between boiler and engine would balance the atmospheric pressure (14.7 pounds per square inch); assuming, further, a ratio of expansion of 12 and a back pressure of 2 pounds per square inch absolute, our formula becomes

$$p_m = 250 \left(\frac{1 + 2.4849}{12} \right) - 2 = 72.6.$$

This theoretical mean effective pressure is affected by what is known as a card factor, which takes account of the loss of pressure between cylinders, and of the rounding off of the corners of the indicator cards, due to wire drawing, compression, etc. This card factor may be assumed at 70 percent, in which case our working mean effective pressure becomes 49.4 pounds per square inch.

Reverting to the horsepower forumla, and substituting for P, L and N, their values already found or assumed, we may solve for A and obtain:

$$A = \frac{8{,}500 \times 33\,000}{49.4 \times 4 \times 240} = 5{,}851.$$

This would account for a low-pressure cylinder with a diameter of about 86¼ inches. It may be more convenient to use two low-pressure cylinders, each of an area of 2,925 square inches, or a diameter of 61 inches.

Assuming a cut-off in the high-pressure cylinder at 0.6 of the stroke, the ratio of area of the low-pressure to the high-pressure cylinder would be 12×0.6, or 7.2 to 1. The high-pressure area would be, therefore, $5{,}851 \div 7.2 = 813$ square inches. This gives a diameter of a trifle more than 32 inches. The area of the intermediate-pressure cylinder is usually made a mean proportional between the high pressure and the low pressure. In the present case this would be $\sqrt{5{,}851 \times 813} = 2{,}180$. This would account for an intermediate-pressure diameter of about 52 2/3 inches.

If we take our cylinders at 32, 53 and 61 inches, remembering that there are two of the latter, an engine built on these figures ought to fulfil the main features of the design.

PERSONAL

Carl C. Thomas has resigned the position of professor of marine engineering in Cornell University to accept the chairmanship of the Department of Mechanical Engineering in the University of Wisconsin. Prof. Thomas will assume the duties of the new position at the opening of the fall term, Oct. 1, of this year.

Obituary.

George W. Quintard died suddenly Sept. 5, after a long, busy and successful career. Mr. Quintard was the founder of the Quintard Iron Works, and was for many years at the head of a line of steamers running between New York and Charleston, S. C.

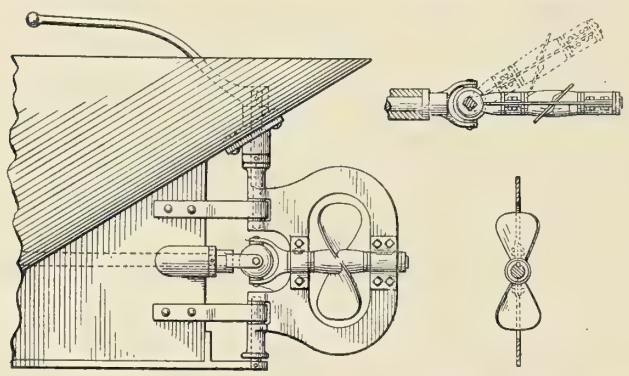
SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

887,986. STEERING PROPELLER. HARRY L. WARD, LONG BEACH, CAL.

Claim.—In combination with a boat provided with a stern post and a bracket secured thereto, of a removable pin in the bracket, a removable steering post in alinement with said pin and having a squared portion and a journal at its lower end, and a tiller at its upper end, a



rudder, provided with a socket for engaging with said squared portion and journal, the central portion and edge of the rudder being recessed, curved plates on the rudder to form bearings, two straps on the stern post, each provided with a socket for engaging with said pin and journal, respectively, in the recesses of the rudder edge, a propeller shaft journaled in the bearings of the rudder, having a universal joint on its forward end, a propeller on the shaft in the central recess of the rudder, and a shaft in the vessel connected with said universal joint. One claim.

888,390. MACHINERY FOR PROPELLING VESSELS. GUSTAF DALEN, STOCKHOLM, SWEDEN.

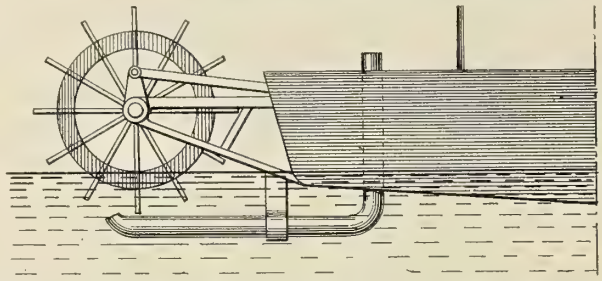
Claim 1.—Two hollow coaxial shafts, two turbine wheels, each mounted on one of said shafts and rotating them in opposite directions, a partition in the inner shaft and means for causing the working fluid to pass through a part of the inner shaft on one side of said partition to said wheels, and after leaving said wheels through said shaft on the other side of said partition to exhaust. Four claims.

888,503. STEAMSHIP. AMAND M. HUREL, NEW YORK.

Claim.—A ship, ovoidal in plan, provided with a substantially flat bottom, with propelling means at one end, and with propelling means at each side of its widest portion, each of such propelling means being movable independently of the other. One claim.

888,274. MARINE VESSEL. GEORGE F. TRISHMAN, OAKLAND, CAL.

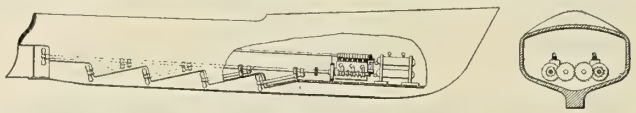
Claim 4.—The combination with a propeller-driven marine vessel, of a tube open at each end and extending from a point adjacent to the



propeller of the vessel upward to a point above the waterline, whereby upon the operation of the propeller, air is drawn down through the tube and out of the submerged end thereof. Six claims.

888,586. BOAT-PROPELLING APPARATUS. JOHN E. CARROLL, PHILADELPHIA, ASSIGNOR TO CO_2 DEVELOPMENT COMPANY, PHILADELPHIA.

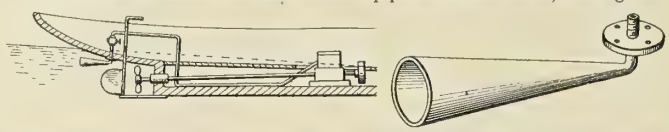
Claim 1.—Propelling mechanism for boats, comprising a fore-and-aft



motor-driven shaft, a propeller mounted thereon, inclined auxiliary shafts geared to said motor-driven shaft at intervals in the length thereof, and propellers on said auxiliary shafts. Four claims.

890,014. MUFFLER OR EXHAUST DEVICE FOR MARINE MOTOR. ALVAH BARBOUR, SWANS ISLAND, MAINE.

Claim 1.—A nozzle for the exhaust pipe of motor boats, having one



end adapted to connect with said exhaust pipe and the other end terminating with a conical, outwardly flaring and rearwardly discharging mouth piece, submerged below the waterline, and with its axis approximately parallel to the same. Four claims.

890,045. BOAT. CHARLES E. GRANROSE, PHILADELPHIA.

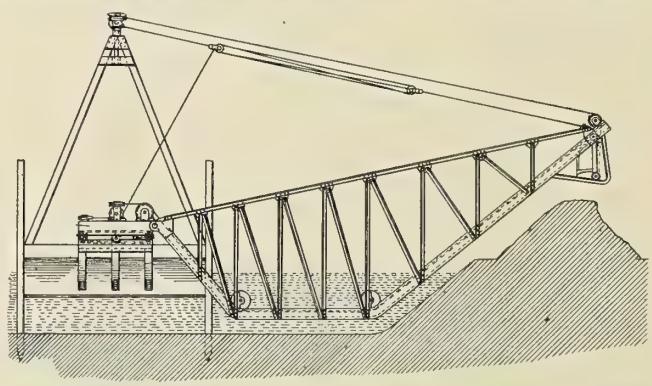
Abstract.—The object is to provide a boat with a pair of sliding boards on each side of the keel, which are so arranged that they can be moved up and down and secured in their adjusted position, so that when the boat is on its starboard tack, the port board will be lowered, which will prevent the boat from drifting laterally when on an uneven keel. Another object is, to provide a boat with curved boards which are mounted in curved wells, whereby when lowered and the boat is on an uneven keel the board will stand vertically. Two claims.

890,470. DREDGING APPARATUS. HARRISON S. TAFT, NEW YORK, AND ULDRIC THOMPSON, JR., HONOLULU.

Claim 2.—The combination in a laterally movable dredge, of a vertically adjustable dredging instrument, a diagram table, mounted on the dredge, a tracer movable over the diagram table, and connections between the tracer and the dredging instrument to change the position of the tracer in relation to the table as the dredging instrument is raised or lowered, and means mounted on the dredge to disclose the amount of lateral movement of the dredge. Thirty-two claims. See description, page 168, April, 1908.

890,909. DREDGE. CHARLES C. JACOBS, CHICAGO, ASSIGNOR TO F. C. AUSTIN DRAINAGE EXCAVATOR COMPANY, CHICAGO CORPORATION.

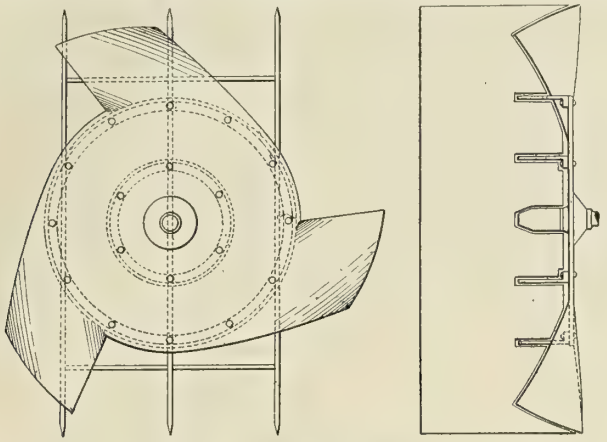
Claim 1.—In a dredge, the combination of a boat, a trackway



hinged to said boat and shaped in part at least to conform to the desired inclination of the bank, an excavating bucket adapted to travel on said trackway, and means to actuate said bucket. Eight claims.

890,973. SHIP'S PROPELLER. PADONE FILIPPI, PARIS, FRANCE.

Claim 1.—In a screw propeller, a broad, flat circular disk constituting the central portion of the propeller, and a plurality of blades extending outward from the periphery of said central disk, the forward edge of each blade being substantially on a prolonged radius of the



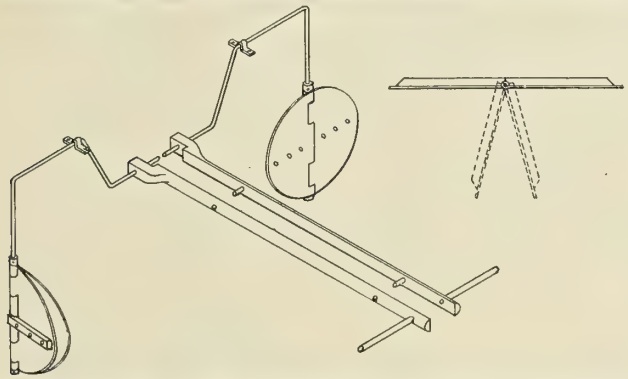
disk and the rear edge conforming approximately to a tangent of said disk, each of said blades having rearwardly turned face, whereby the water thrown outward by centrifugal force from the central portion of the propeller is received upon the face of the blades, and the formation of vortexes at the rear of the propeller is prevented. Three claims.

891,214. HYDROMOTOR. ANTON GRAF, NEWBURY, MASS., ASSIGNOR OF ONE-HALF TO JOHN JOYCE, ANDOVER, MASS.

Claim 2.—In an apparatus of the character described, a vessel, a source of steam pressure, an injector for said pressure, an injector chamber in which said injector is located, an inlet duct open to the water at the front of the vessel and communicating with said injector chamber, into which the water is drawn by said injector, a motor operated by the flow of water and the steam pressure, an exhaust duct opening into the water at the rear of the vessel for the exhaust of the steam pressure and water from said motor, and valves controlling said water-inlet duct and said exhaust duct. Seventeen claims.

892,418. HAND-OPERATED MECHANISM FOR ROWBOATS. SVEN G. HALLMAN, HINCKLEY, MINN.

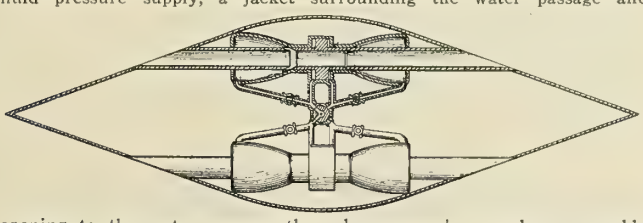
Claim 1.—In combination with a boat, a pair of independent horizontal shafts journaled across the gunwale of the boat, and having down-



wardly bent ends, a hinged propeller blade carried by the downwardly bent outer end of each shaft, a rearwardly extending handle secured upon the downwardly bent inner end of each shaft, and means for detachably connecting said handles. Two claims.

892,454. BOAT PROPULSION. ARVID T. RONSTROM, CHICAGO.

Claim 3.—In combination with the hull of a vessel having a waterway extending through said vessel longitudinally thereof, a source of fluid pressure supply, a jacket surrounding the water passage and



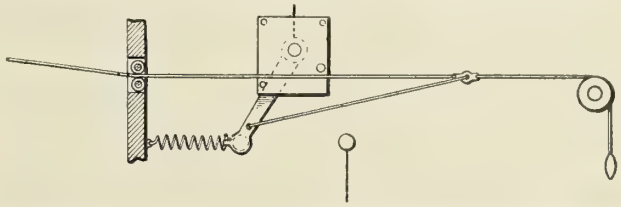
opening to the water passage through an annular nozzle; a movable means for closing said nozzle, constituting part of the waterway, and a connection between the source of fluid pressure supply and the jacket. Four claims.

893,116. SHIP. GEORGE E. WALTON, DAYTONA, FLA.

Abstract.—The object of the invention is primarily to provide a means whereby goods or merchandise, lumber for instance, may be loaded and transported without breaking bulk or rehandling when the line of transportation includes shallow as well as deep-water navigation. There is provided a vessel of proper under-water formation to adapt it for deep-water navigation, but having no deck housing, save at the bow, whereby it is adapted to receive in orderly arrangement a series of barges, such barges when in place forming the superstructure of the vessel hull. To facilitate the assembling or loading of the barges on the deep-water hull and the unloading of the same when the barges are to be used as separated units for shallow-water navigation, the deep-water hull is adapted to be submerged to a point where the barges may be floated into or out of position, the submergence or raising of the hull being effected by the filling or emptying of watertight compartments in the hull itself. Four claims.

892,572. SIGNAL DEVICE. JOSHUA W. ATLEE, RIVERTON, N. J.

Claim 2.—In a nautical signal device, an apparatus comprising means



for displaying an inclined bar of light, a sound-producing apparatus, and means for simultaneously displaying said light and operating said sound-producing apparatus. Three claims.

British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

1,217. TURBINES. J. ATKINSON, GLENBURN, STOCKPORT.

Loss of energy incurred on reducing the inlet pressure for governing purposes is reduced by arranging an adjustable injector so that the fresh steam draws in partly expanded steam from an intermediate point or from the exhaust. The invention may be applied to multi-stage velocity turbines, and in this case the injector may be combined with the nozzle delivering to the blades. It may be applied for lighter loads in cases where steam at boiler pressure is used for full loads, and a by-pass is provided for overloads. The lower stages from which steam is drawn may form separate units. Several sets of injector nozzles may be used, and they may be hand controlled. It is stated that with this device the turbine is shortened, the drum may be of one diameter throughout, less leakage occurs at the earlier rings of blades, and lower speeds are obtained.

1,397. MARINERS' COMPASSES. L. W. P. CHETWYND, F. W. CLARK, AND KELVIN & JAMES WHITE, GLASGOW.

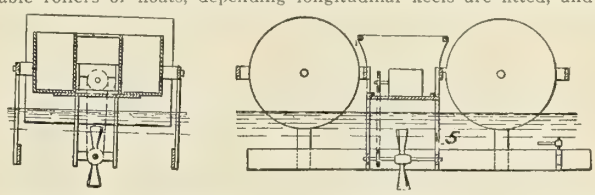
The athwartship and fore-and-aft correcting magnets are carried by vertical chains or bands running over sprocket wheels, which are rotated by means of worm gearing in order to move the magnets towards or away from the compass needles. The spindles carrying the sprockets of the fore-and-aft magnets are rotated by worms on a shaft, which may be turned by a hand wheel placed on the squared end. Similarly the sleeve carrying the sprockets of the athwartship magnets is rotated by a worm. The shafts are prevented from rotating after adjustment by means of pawl-and-ratchet mechanism. The binnacle door is provided with pins, which pass over the pawls and lock the ratchet mechanism when the door is closed.

2,807. SHIPS' BERTHS, ETC. HOSKINS & SEWELL, BORDESLEY, AND C. JOHNSON, HIGHGATE, BIRMINGHAM.

Relates to berths for ships, dormitories, railway carriages, etc., and to couches, seats, settees, etc., of the type having a main bottom frame, provided with a folding or turn-down extension, so that they can accommodate either one or two persons, the wire or other mattress fabric being in a single piece, a part of which is adapted to be folded down along with the extension. The object of the invention is to provide means for supporting and stretching the mattress fabric when the extension is turned down, such means also serving to secure and brace the extension when the latter is in the horizontal position. The main section of the bottom frame is formed of three angle-iron bars, and may be slidably supported in brackets on the bulkheads at the head and foot of the berth. The extension is formed of three bars and is connected by butt hinges to the frame. Secured to the frame by means of brackets is a rail, which lies at a sufficient distance below the mattress to prevent an occupant of the berth from resting upon it.

3,096. SHIPS AND BOATS SUPPORTED ON ROLLERS. A. FAYOL, BORDEAUX, FRANCE.

In that type of vessel in which the body is supported on smooth rotatable rollers or floats, depending longitudinal keels are fitted, and be-



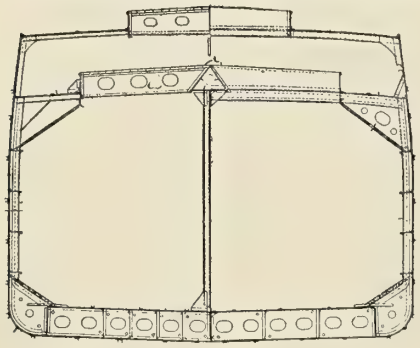
tween them the propeller works. The boat is formed by a frame and carrying shafts, on which float-cylinders freely rotate. Two parallel keels are provided, and also cross-pieces, which support a platform for the steersman. In a cage is mounted the screw propeller, which is actuated by a motor through chain or other gearing. Two cars for the reception of passengers, goods, etc., connected by stays, rest freely on the platform so as to be automatically detached if the propulsion apparatus sinks. An aërostat may replace or supplement the float-cylinders.

4,037. COALING SHIPS, ETC. A. BLIEDUNG, HAMBURG, GERMANY.

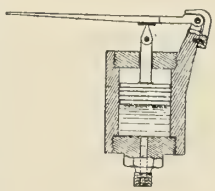
In automatic coaling apparatus for bunkers and like spaces in which a scraper conveyer having a number of closable apertures in its channel is arranged at the top of the bunker, in order to enable the storage space to be entirely filled, the chain carrying the scoops or buckets is diverted horizontally by passing it around rollers mounted on vertical axes. The channel, which is arranged under the bunker deck or on a second ceiling or deck, is of a depth equal only to that of the height of the rollers and scrapers, and thus takes up a very small space. The material is carried around from the loading shoot and is deposited into any part of the bunker through apertures, which may be closed by doors.

3,455. SCREW PROPELLERS. W. M. BERGIUS, GLASGOW.
Relates to means whereby the blades of a propeller which are adapted to feather or fold may be operated by a key from the deck or hold of the vessel. The two blades, which are secured to the boss by a bolt, can be turned into the effective radial position, or the idle position, by means of a key at the end of a shaft. This shaft is carried by a bracket, or is guided by a stuffing-box carried through the hull. The key fits over the bolt head and engages with snugs at the root of each of the blades, the shaft being first turned into suitable position, indicated by marks thereon.

3,502. SHIPS. J. A. RAMAGE, HEPBURN, DURHAM.
In cargo vessels which are fitted with permanent central longitudinal bulkheads, the hatchways are made as long as possible and of the full width of the deck, with the exception of a portion at each side sufficient to maintain the strength of the structure. Each hatchway is divided into two portions, of a width nearly equal to an ordinary hatchway, by a longitudinal girder, which may be of triangular, round, or other section. The ends of the girder are attached to the end coverings of the hatchway and to the deck. The longitudinal bulkhead may extend through the engine and boiler rooms, but always extends throughout the cargo spaces. The hold beams are dispensed with by employing strong frames, and strong gusset plates avoid the use of hold pillars.



3,502.



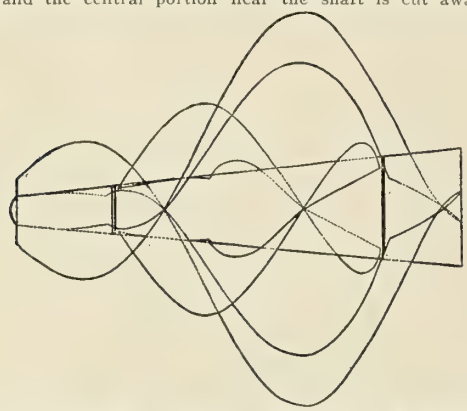
3,524.

3,524. SHIPS' LOGS. H. G. A. KLAPPROTH, HANOVER, GERMANY.
In ships' logs and speed indicators of the kind in which a plate is subjected to water pressure, an inelastic plate is pivoted to a bracket on a cylinder, and bears against a knife edge attached to the piston, from which the pressure is communicated by means of viscous oil or glycerine to a manometer, which may be empirically divided to indicate speed.

3,531. SHIPS. W. DOXFORD, SUNDERLAND.
In vessels for carrying an easily shifting cargo in bulk, inner upright walls are fitted some distance in from the hull, and so arranged that when the vessel is transversely inclined within the usual range of inclinations of the vessel at sea, the weight of the cargo and the buoyancy create a restoring couple in all conditions of loading. The spaces between the cargo hold and the outer shell may be used for water ballast, or be left empty. In some cases the bottom is reduced in depth as much as loading regulations will permit.

3,614. SHIPS' STEERING GEAR. SIEMENS BROS. DYNAMO WORKS, WESTMINSTER, AND H. WRIGHT, STAFFORD.
The tiller rods are operated by hydraulic rams supplied with fluid under pressure by a single pump, operated by a rotary motor. The pump is provided with a device whereby it is automatically put in and out of action when the moving part is started and stopped, thus enabling the motor to run continuously. A control valve regulates the admission of the fluid from the pipe to one or other of the rams, and simultaneously the exhaust from the other ram to a tank. The pump is driven by the motor, and is held out of action by any suitable device when the valve is closed.

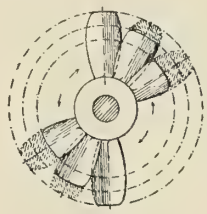
3,930. SCREW PROPELLERS. A. H. HAVER, NEWCASTLE-ON-TYNE.
The blade area is disposed much more along the shaft than in a radial direction, and the central portion near the shaft is cut away so that



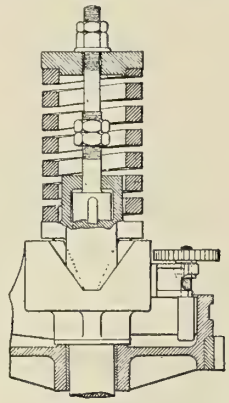
the rear part of the blade works in a separate part of the water. The blades may be affixed to a boss, tapering towards the after end and slightly tapered towards the fore end. Two sets of blades may be used, each with their centers cut away and disposed one within the other, and attached to bosses. The concentrically-placed blades may be rotated in opposite directions, or one may be stationary and the other rotating.

4,445 AND 4,446. TURBINES. B. LJUNGSTROM, STOCKHOLM, SWEDEN.
The vanes and guide blades of radial-flow turbines consist of perforated cylinders, the blades being supported by terminal and intermediate rings. The cylinders or blade rings are either made in one continuous piece, or the vanes and supporting rings are made separately, and are afterwards connected together. A single-stage marine turbine is formed with two expansion chambers. The stationary blade rings are secured to plates. By forming the blade rings in the above manner, the blades may be made with a very small radial extension, whereby the total diameter of the turbine is reduced.
Sets of turbine vanes are made in one piece in the form of perforated plane rings, cylinders, cones, etc. The holes are cut from the solid by a tool which is reciprocated longitudinally, and rocked so that the sides cut alternately. In modified forms of grooves, two or more tools are employed to cut the slots, acting from the same or from opposite sides. Side tools may be employed to trim the ends of the slots, the cuttings being removed by oil jets.

4,509. SCREW PROPELLERS. G. MACKANESS AND J. BARNES, SYDNEY, AUSTRALIA.
In screw propellers of the kind having manifold blades of varying diameters arranged in clusters aslant of the boss, the blades are similarly proportioned up to the limit of their diameters, each blade being similar to the one preceding it, but with a portion of the outer end removed. The ratio of the areas of the smallest and largest blade being determined, the diameter of the smallest blade is obtained, and the diameters of the intermediate blades are arranged so that the areas of the blades gradually diminish. The blades overlap slightly when viewed in end elevation, and are arranged upon the boss in the opposite direction to the pitch.



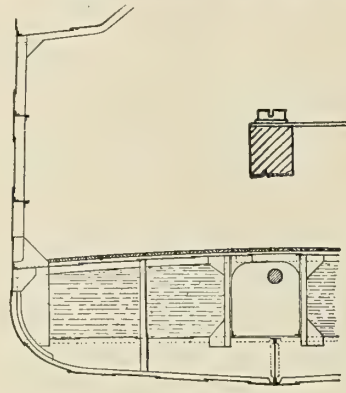
4,509.



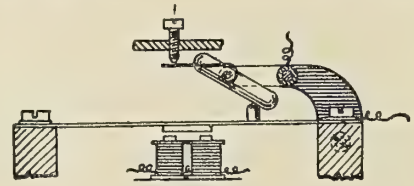
4,754.

4,754. STEERING GEAR. W. G. GIBBONS, EDINBURGH.
In a device for absorbing abnormal shocks, such as those due to a heavy sea striking the rudder, a clutch member, keyed to the steering shaft, but free to slide endways upon it, has upon one end a series of faces inclined to the axial plane. These faces engage with counterpart inclined faces on a second clutch member, which is free to rotate upon the shaft, but cannot move endways. The latter member is operatively connected to a pinion which is loose on the shaft, and is driven from the steering gear through a friction clutch. The inclined faces are in series of opposite hand, so that control of movement in either direction is effected.

5,660. SHIPS' PROPELLER SHAFT, TUNNELS, TANKS. J. T. DUNCAN, CARDIFF.
The plating of the roof of the propeller-shaft tunnel is made continuous from side to side of the ship for the entire length of the ship from the engine-room bulkhead to the stern bulkhead. The wing portions constitute ballast tanks, and provide an uninterrupted floor to the hold space.



5,660.



6,253.

6,253. SUBMARINE SOUND SIGNALING. J. GARDNER, KNOTT END, LANCASHIRE.
Relates mainly to the disposition of the microphonic contacts on the diaphragm or blade of the receiving instrument for submarine sound signaling. The pulsatory currents, generated at the telephonic transmitter which receives the sounds, and flowing in the coils of the magnet, if of the proper frequency, cause the armature and tuned strip to vibrate. When the strip is at rest, a constant current flows through the electrodes of the microphone, and holds a signal-operating electromagnetic device, which is in series with the electrodes, in position; but on the arrival of the appropriate sound at the receiving transmitter, the electrode is vibrated and an increase in resistance at the point of contact of the electrodes takes place, and the resulting diminution of the current causes the signal-operating electromagnetic device to be actuated. According to the present invention there is very little vibration of the weighted strip near its fixed ends, and the change from the vibrating part to the non-vibrating part takes place with comparative suddenness.